

KANSAS-LOWER REPUBLICAN BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Lower Kansas River

Water Quality Impairment: *E. coli* Bacteria

(Replaces Fecal Coliform Bacteria TMDLs for Kansas River at Lawrence and Lower Kansas River)

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Lower Kansas

Counties: Johnson, Wyandotte, Leavenworth, Douglas, and Jefferson

HUC 8: 10270104

Ecoregion: IX (Southeastern Temperate Forested Plains and Hills) – 40 (Central Irregular Plains) – 40B (Osage Cuestas)

Drainage Area:

About 1226 square miles between Kansas City and Lecompton, including 540 square miles in the Stranger Creek watershed, but not any drainage in the Wakarusa River watershed above Clinton Dam. (Figure 1)

Main Stem Segments:

1, 2, 3, 4, 18, 19, 21 & 23 from the confluence with the Missouri River to the confluence with the Delaware River above Lecompton.

Tributary Segments:
(moving upstream)

Turkey Creek (77)
Mattoon Creek (1178)
Muncie Creek (55)
Barber Creek (373)
Little Turkey Creek (62)
Tooley Creek (379)
Mill Creek (39)
East Mission Creek (61)
Wolf Creek (53)
Little Kaw Creek (59)
Cedar Creek (38)
Kill Creek (37)
Stranger Creek (5)
Captain Creek (72)
Wakarusa River (24)
Kent Creek (73)
Mud Creek (20)
Baldwin Creek (69)
Buck Creek (22)
Stone House Creek (57)
Oakley Creek (56)

Designated Uses: **Primary contact recreation – Class B:** All Main Stem Kansas River Segments, Wakarusa River and Kill and Turkey Creeks;
Primary contact recreation – Class C: Mud, Captain, Stranger, Cedar, Mill, Little Kaw, Wolf, and Little Turkey Creeks;
Secondary contact recreation – Class b: Oakley, Stone House, Baldwin, Buck, Kent, East Mission, Tooley, Muncie, Barber and Mattoon Creeks

1998 303d Listing: Table 1–Predominant Point and Non-point Source Impacts for Fecal Coliform Bacteria – TMDLs developed and approved in 1999-2000 for Kansas River at Lawrence and Lower Kansas River; Bacteria TMDLs also developed for Lower Wakarusa River, Stranger Creek, Kill Creek, Cedar Creek and Mill Creek

Impaired Use: Primary and Secondary Contact Recreation along Kansas River.

Water Quality Standard: Geometric Means of at least five samples of *Escherichia coli* (*E. coli*) collected in separate 24-hour periods within a 30-day period shall not exceed the following criteria beyond the mixing zone

Primary Contact Recreation – Class B: 262 CFU/100 ml from April 1 to October 31; 2358 CFU/100 ml from November 1 to March 31

Primary Contact Recreation – Class C: 427 CFU/100 ml from April 1 to October 31; 3843 CFU/100 ml from November 1 to March 31

Secondary Contact Recreation – Class b: 3843 CFU/100 ml from January 1 to December 31
(KAR 28-16-28e(c)(7)(D & E))

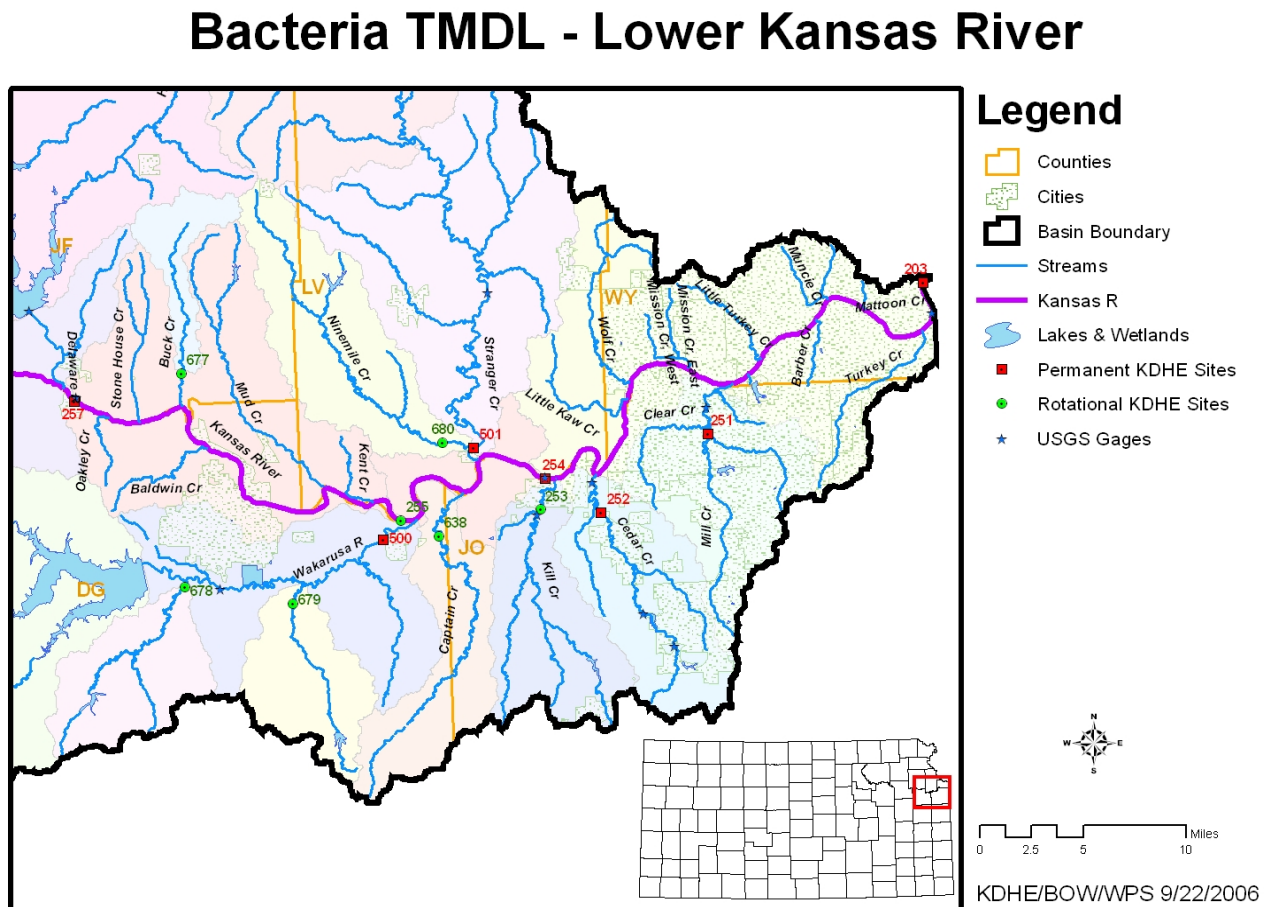
2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303d: Not Supporting Primary or Secondary Contact Recreation

Monitoring Sites (Figure 1): Stations 203 (Kansas City); 254 (Desoto); 255 (Eudora) and 257 (Leocompton); supplemented by Stations 127 (Wyandotte Co. Line); 250 (Bonner Springs) and 256 (Lawrence). Continuous turbidity sensor data obtained from USGS at Kansas River near Desoto site (06892350), along with regularly scheduled samplings of *E.coli* bacteria. Sampling changed for KDHE stations in July 2003 from fecal coliform bacteria to *E.coli* bacteria

Period of Record: Station 203: 1967-2003 (fcb); Station 257: 1985-2003 (fcb); Station 254: 1990-2003 (fcb); Station 255: 1986-1989, 1996-1998, 2003 (fcb); Stations 203, 254 & 257 have *E.coli* data from 2003-2005; Station 255 has *E.coli* data from 2003.

Figure 1. The Lower Kansas River Watershed



Supplemental Stations: 127, 250 & 256: 1996-1998 (fcb).

USGS – Desoto *E. coli* sampling: 1999-2004; continuous turbidity monitoring: 1999-2005.

Flow Record: Kansas River flow was measured daily at USGS stations near Lecompton (06891000) and near Desoto (06892350). Calculations based on period 1970-2005.

Long Term Flow Conditions:

Flow Condition	Lecompton	Desoto
Low Flow (90 th Percentile)	1100 cfs	1200 cfs
Median Flow (50 th Percentile)	3560 cfs	3940 cfs
Average Flow (~ 28 th Percentile)	7600 cfs	8450 cfs
High Flow (10 th Percentile)	19,600 cfs	21,800 cfs

Current Conditions:

Historic Fecal Coliform Bacteria in the Kansas River

Historic bacteria levels along the Lower Kansas River are highly variable, with a slight decrease over time apparent at Kansas City (Figure 2). Examination of fecal coliform bacteria levels at Lecompton indicates almost constant loading across flow conditions prior to 2001 (Figure 3). However, from 2001-2003, there was notable decrease in bacteria counts, particularly at lower flows. This coincides with the start-up and operation of disinfection technology at the Topeka Oakland Wastewater Plant upstream of Lecompton. Similar decreases in recent years are noted at the Kansas City station, but the decrease, as indicated by the slope of the recent trend line, is tempered by intervening sources that had yet to disinfect their effluent (Figure 4). The strong influence of the Topeka Oakland Plant can be seen in comparing the routine fecal bacteria samples taken from the river at Lecompton, Desoto and Kansas City over 1990-2003 (Figure 5). The average bacteria count at Lecompton was 1140, significantly higher than the counts at Desoto (360) and Kansas City (510). The difference between Desoto and Kansas City was slightly significant. Bacteria levels at Kansas City over the 1967-1985 period were similarly bad (2010), but improved over 1986-2003 (650), probably due to disinfection at many of the major wastewater plants between Lawrence and Kansas City, as well as improvements in disinfection upstream to Salina.

More recent data on *E. coli* (2003-2005) reflect the impact of ongoing disinfection treatment, *E. coli* levels at Lecompton, Desoto and Kansas City were 73, 44 and 209, respectively (Figure 6). This slightly significant difference probably indicates the remaining need for disinfection of certain point sources between monitoring station 254 near Desoto and monitoring station 203 in Kansas City, located near the mouth of the Kansas River.

Figure 2. Fecal Coliform Bacteria Counts on Lower Kansas River, 1967-2003

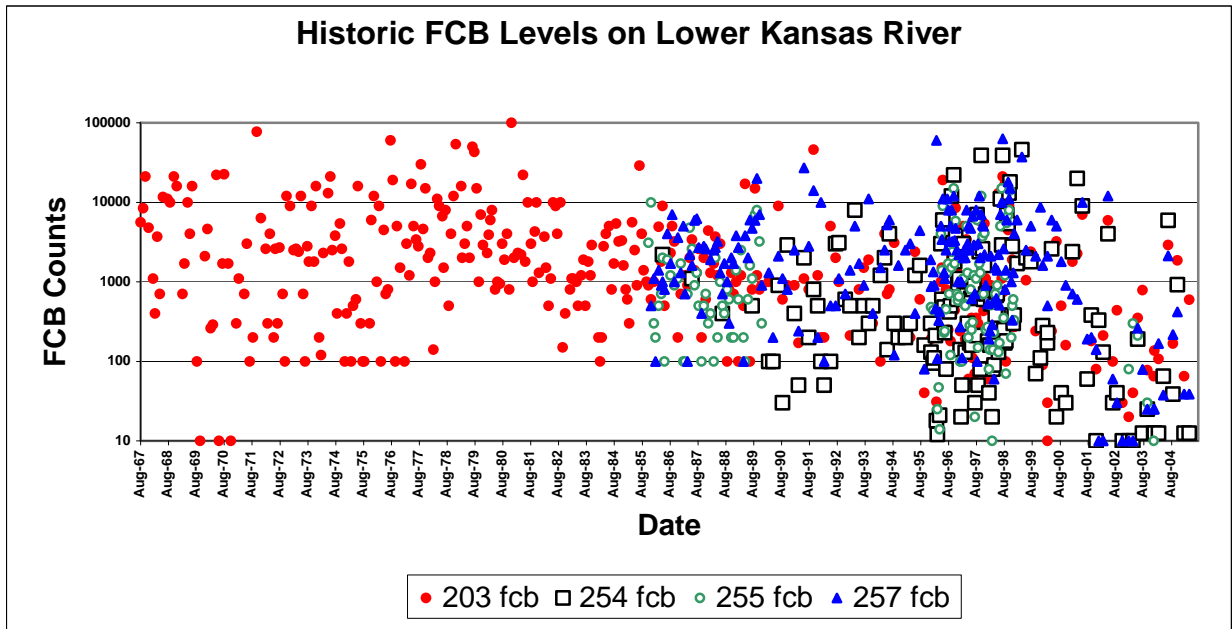


Figure 3. Bacteria Counts under Flow Conditions on Kansas River near Lecompton

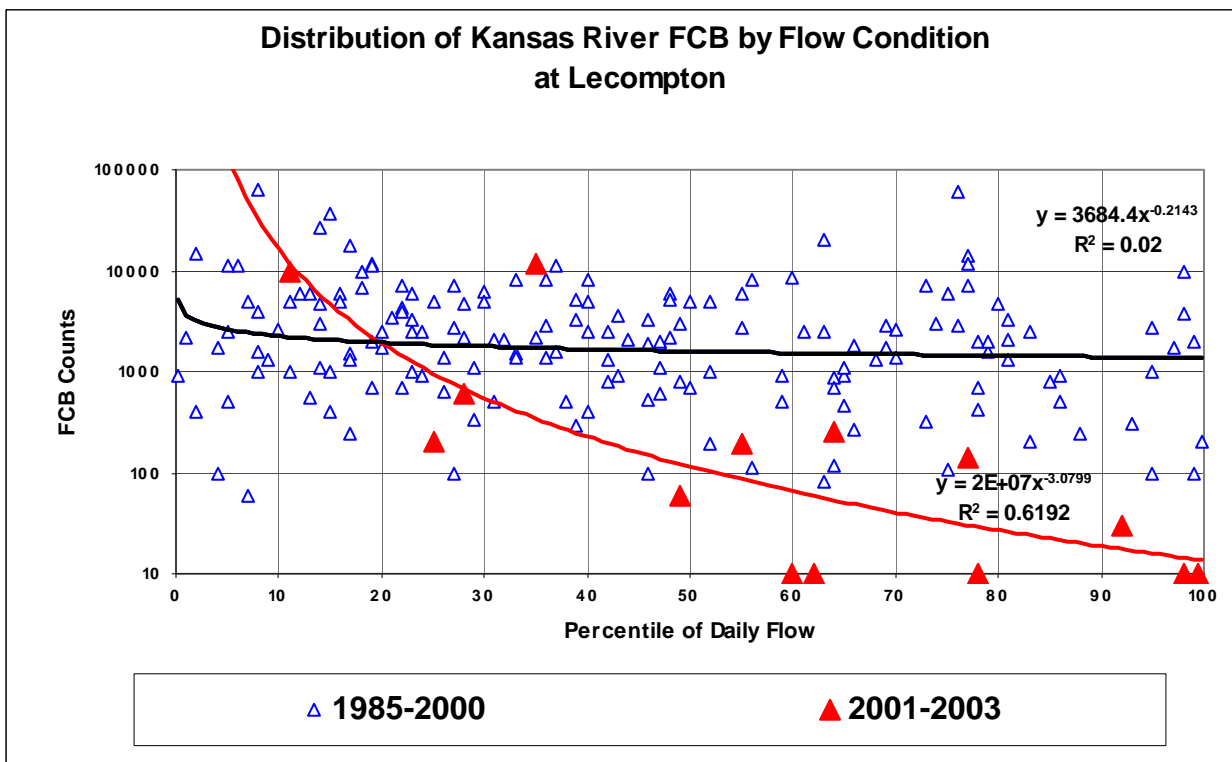


Figure 4. Bacteria Counts under Flow Conditions on Kansas River at Kansas City

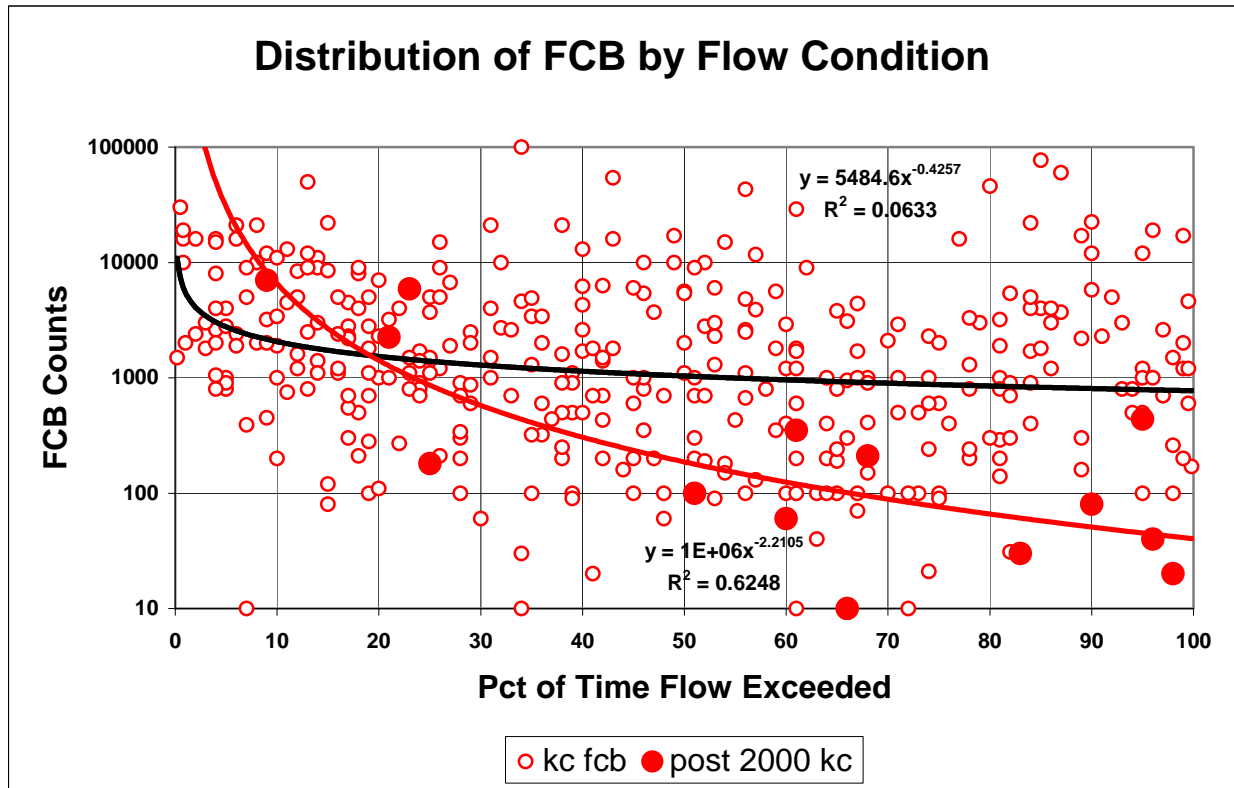


Figure 5. Comparison of Average Log FCB Counts at Kansas City, Desoto and Lecompton

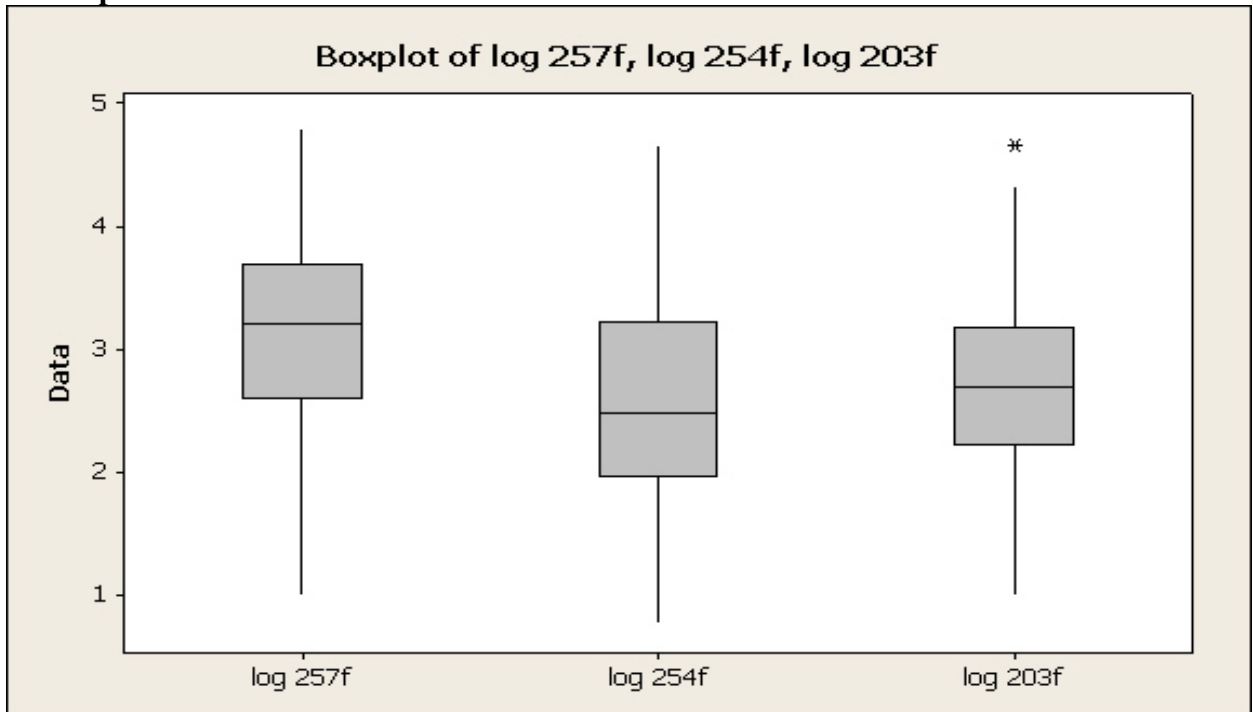
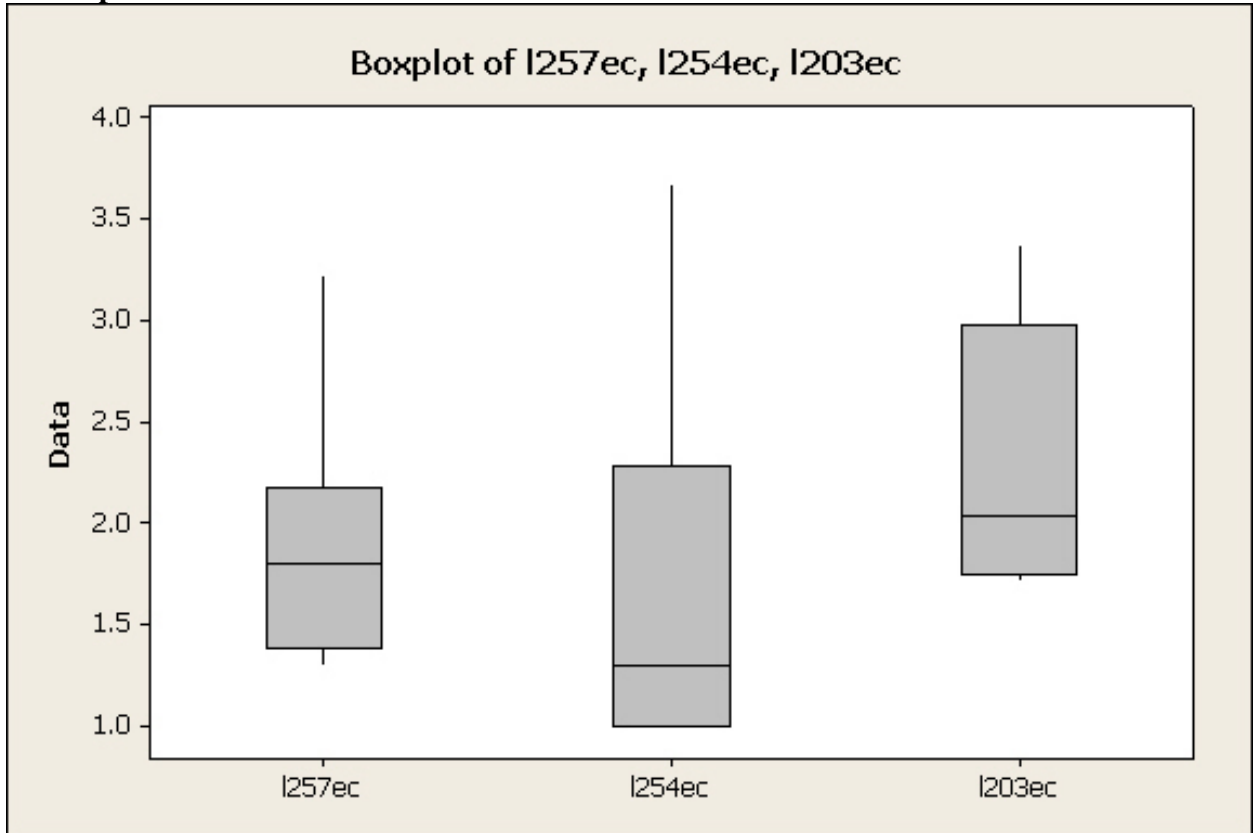


Figure 6. Comparison of Average Log E.coli Counts at Kansas City, Desoto and Lecompton



Governor's Water Quality Initiative

Over 1996-1998, as part of Governor Graves' Water Quality Initiative, KDHE sampled the Kansas River on a biweekly basis. Table 1 summarizes the pertinent averages for stations along the river between Lecompton and Kansas City. Larger values are noted at Lecompton, again, likely caused by the Topeka-Oakland plant. Occasional high values are also seen at Kansas City, but the stations lying between the entry and terminal ends of the Lower Kansas River have similar concentrations. Die-off is apparent between Lecompton and Lawrence and there seems to be some die-off between Lawrence and the Wyandotte County Line stations. The corresponding annual and seasonal bacteria levels reflect direct association with baseflow and runoff conditions; 1997 was a fairly dry year, while 1998 was wet. Therefore, while the influence of certain point sources can be discerned, the overriding factor in elevating bacteria levels in the Lower Kansas River continues to be weather-driven runoff from urban and rural landscapes above Station 203 near the mouth of the river in Kansas City.

Table 1. Geometric Means of Bacteria Data Collected Along Lower Kansas River, 1996-1998

Geo Mean	KC	WY Co Line	Bonner Sprgs	Desoto	Eudora	Lawrence	Lecompton
1996	544	381	495	454	675	625	2439
1997	456	241	347	471	634	706	2067
1998	910	473	565	625	624	664	1620
1996-98	610	351	459	512	642	665	2009
96 Primary	820	557	765	740	726	902	3210
97 Primary	452	246	441	511	753	854	2786
98 Primary	1773	747	882	1058	1147	1169	2561
96-97 Secondary	487	374	290	452	520	643	1342
97-98 Secondary	394	215	227	265	299	290	916

Tributary Contribution of *E. coli*

Table 2 displays the concurrent *E. coli* sampling on the Lower Kansas River and its main tributaries since 2003. Of the 8 single samples over the 262-count criterion at Kansas City, the five largest concentrations can be attributed to upstream contributions. Mill Creek and Stranger Creek appear to be consistent sources. The five largest concentrations at Kansas City correspond to the five largest concentrations at Desoto and four largest at Lecompton.

Flow conditions at Desoto and Lecompton were high for four of the five highest levels at Kansas City. The other three high instances had normal flows, although rain occurred prior to sampling in all cases. Stranger Creek is the largest tributary to the Lower Kansas River. The Wakarusa River is almost as large, but 70% of the drainage is controlled by Clinton Dam. Mill Creek might be the most urbanized stream monitored by KDHE along the Lower Kansas River.

Table 2. Concurrent *E. coli* Sampling Along Lower Kansas River and Tributaries, 2003-2006

Date	KC	Mill	Cedar	Kill	Desoto	Stranger	Wakarusa	Lecompton	Desoto Flow
8/7/03	626	41	31		10	52	75	63	2410 cfs
10/9/03	62	134	85		20	10	74	20	1820 cfs
12/30/03	52	10	74		10	10	52	20	1190 cfs
1/8/04	109	31	52		10	10	10	20	1450 cfs
3/2/04	86	292*	10		10	10	94	134	2310 cfs
5/6/04	52	52	122		52	536	97	30	2420 cfs
7/8/04	2319	477	119		4757	313	122	1692	15,900 cfs
9/9/04	134	368	52		31	613	10	173	3700 cfs
11/4/04	1483*	3448*	1354*		733*	1515*	1354*	336*	1910 cfs
2/3/05	52	10	10	10	10	63	10	31	3010 cfs
4/7/05	474	213	63	75	10	74	959	31	1980 cfs
6/2/05	2382	754	309	2187	1095	5172	1137	110	8030 cfs
8/4/05	63	31	31	10	20	20	108	85	2390 cfs
10/6/05	1281	148	75	171	583	1250	199	496	15,200 cfs
12/8/05	121	10	20	20	31	10	30	10	900 cfs
1/5/06	20	171	10	NA	30	10	20	10	1400 cfs
3/9/06	52	20	31	NA	10	10	41	10	1220 cfs
5/4/06	1153	1153	249	NA	1081	10462	341	1467	8290 cfs
7/6/06	473	323	259	NA	21	171	209	10	1430 cfs

- * Off-season or secondary contact criteria (2358 or 3843 counts per 100 ml) apply

Geometric Mean Sampling

In response to the legislative definition of impairment by bacteria, requiring an exceedance by the geometric mean of 5 samples taken within 30 days, KDHE began to sample the Kansas and Arkansas Rivers in this intensive manner in the summer of 2004. Twelve samplings have been made on the Lower Kansas River at Lecompton, Eudora, Desoto and Kansas City. Figure 7 indicates the individual values of samples taken during each of those twelve 30-day sampling periods required by law. While individual samples may rise above the applicable primary or secondary criteria, the corresponding geometric means, which are the standard for assessing impairment, remain mostly below the respective criteria (Figure 8). However, the terminal ends of the river reach of concern at Lecompton and Kansas City exceeded the primary criterion in April and June of 2006, respectively. Therefore, the river remains impaired even with transitioning to the new E coli indicator and under the geometric mean sampling requirements.

Figure 8 also indicates a uniform level of bacteria averages from Lecompton to Desoto, then a jump in bacteria levels between the Desoto and Kansas City stations. This is likely due to incomplete disinfection at the large wastewater facilities, notably the Mill Creek Regional Plant of Johnson County. Additionally, discharges from Combined Sewer Overflows (CSOs) in Kansas City may contribute bacteria loads to the lower river during wet weather.

For the arithmetic average of the seven primary recreation season samplings, there is no significant difference between the upper three stations and Kansas City (Table 3). The wide variability of individual samples is larger than the differences among station-to-station samples. Once overall geometric means are compared after logarithmic transformation of the data, significant differences arise between the upper three stations and Kansas City. There is no difference between Lecompton, Eudora and Desoto, but all three are significantly less than values seen at Kansas City.

Sampling during the primary recreation season occurred during typically normal flow conditions (Figure 9). Neither extremely high nor low flows were sampled in 2004-2006. Kansas City had higher bacteria levels at the lowest flows sampled. Most samples taken between the 30 and 95 percentile flows were below the primary criterion of 262 counts, however, geometric means in 2006 exceeded the criterion at both ends of the river reach at Lecompton and Kansas City. Additionally, despite the distance between wastewater outfalls and monitoring stations, there could be exceedingly high bacteria in the river immediately below the mixing zones of the wastewater plants in Johnson and Wyandotte counties. Die-off may reduce bacteria contributions from wastewater sufficiently before the flow reaches the next downstream monitoring station. Therefore, current plans to disinfect wastewater at those facilities remain warranted for public health protection reasons. Furthermore, exceedances occurring at higher flows indicate the need to abate bacteria loads from urban stormwater from the metropolitan area as well as Kansas City CSOs.

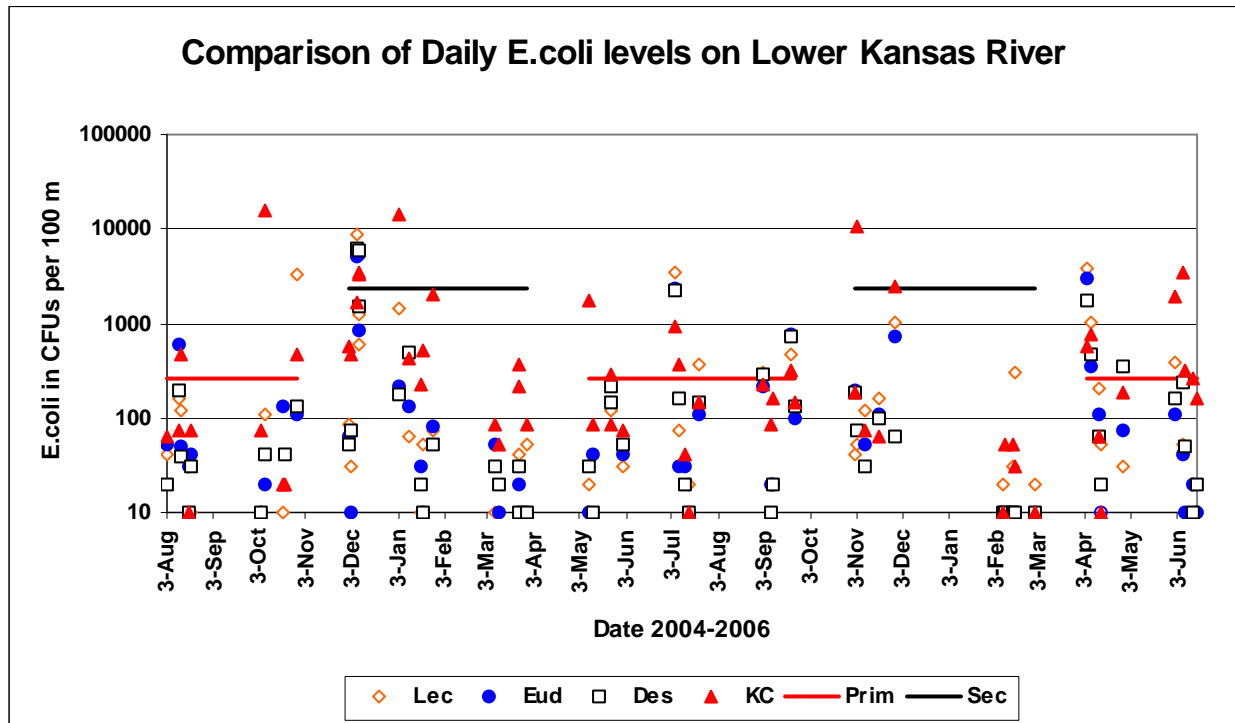
The five samplings during the secondary recreation season occurred at normal to dry

flows (Figure 10). Again, most samples were below the 2358 count criterion, with samples at Kansas City generally being the most for any of the stations. Geometric means approach the criterion, but none exceed it. Nonetheless, the increase in bacteria at low flow between Desoto and Kansas City occurs under the least hospitable ambient conditions in the river, indicating some external loading of bacteria occurs along that lower reach.

Table 3. Average bacteria levels during 30 day sampling periods on Lower Kansas River

Seasonal Average	Lecompton	Eudora	Desoto	Kansas City	Significance Level
Primary-Arithmetic	419	253	227	816	0.313 (NS)
Primary-Geometric	72	62	67	162	0.049 (Significant)
Secondary-Arithmetic	569	533	597	1639	0.224 (NS)
Secondary-Geometric	78	57	57	292	0.009 (Very Significant)

Figure 7. Individual E.coli Samples taken along Lower Kansas River in 2004-2006



Lower Kansas River E.coli Geometric Means

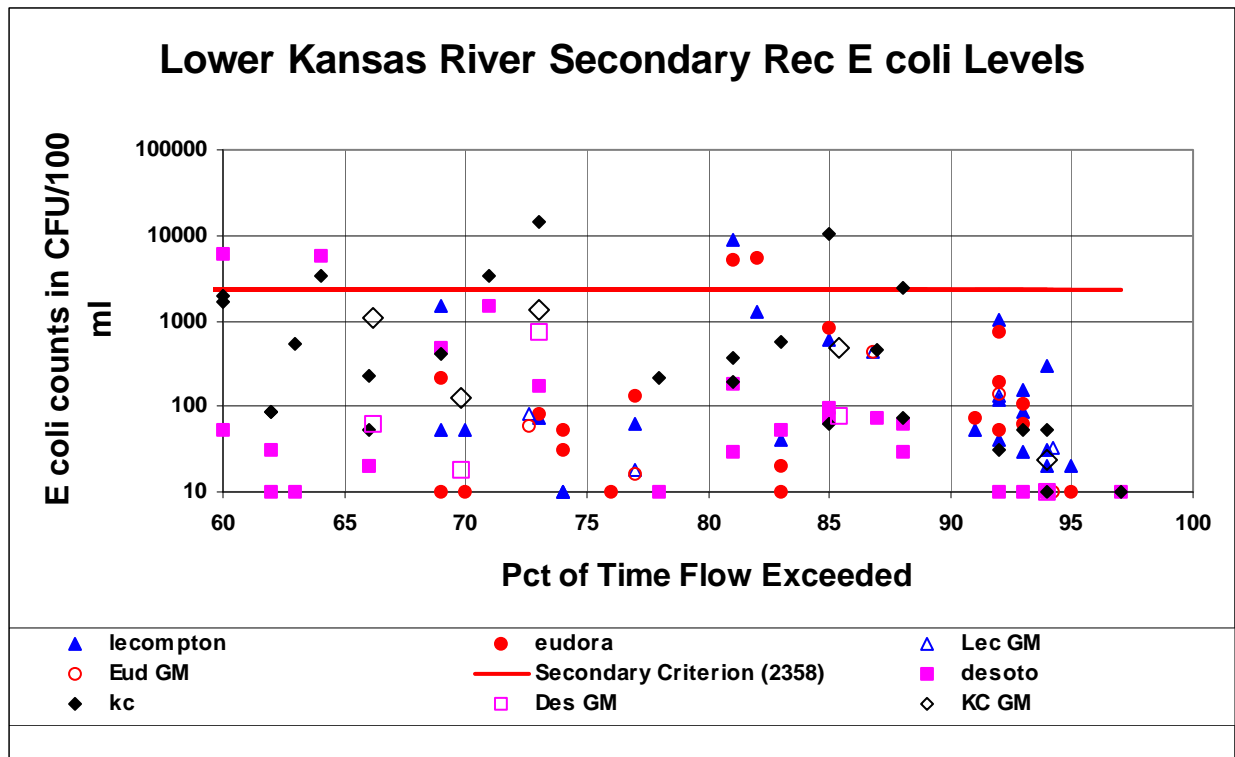
E.coli in CFUs/100ml

Sample Month

Legend: Lec (blue bar), Eud (green bar), Des (red bar), KC (red line with square), Prim (red line), Sec (black line)

Sample Month	Lec	Eud	Des	KC	Prim	Sec
August	40	70	35	70	250	
October	55	35	35	180	250	
December	450	450	750	1400	2500	2500
January	80	60	60	1100	2000	
March	20	18	20	120	1500	
May	40	50	50	180	2500	
July	140	70	100	110	2500	
Sept	90	90	90	160	2500	
Nov	130	140	75	450	2500	2500
Feb	35			25	2500	
April	250	150	200	140	2500	
June	30	25	50	600	2500	

Figure 10. Flow Distribution of Lower Kansas River Bacteria during November-March



Continuous Estimates of Bacteria

Since July of 1999, USGS has operated a continuous sensor for turbidity among other parameters at its Kansas River near Desoto gaging station (Figure 11). Rasmussen and Ziegler (2003) and Rasmussen, Ziegler and Rasmussen (2005) developed regression equations for the Desoto data, relating turbidity to E. coli bacteria counts. The relationships were:

$$2003: \text{Log (E coli)} = 1.40 * \text{log (Turbidity)} - 0.883 \quad [\text{MSE} = 0.35 \text{ log units; } R^2=0.76]$$

$$2005: \text{Log (E coli)} = 1.55 * \text{log (Turbidity)} - 1.16 \quad [\text{MSE} = 0.335 \text{ log units; } R^2=0.71]$$

These regressions were based on 50 samples taken over 1999-2003. KDHE modified the regression by adding KDHE E. coli samples collected at Desoto since 2003 and USGS samples collected in 2004-2005, segregating the data into the primary and secondary recreation seasons and including the percentile flow as an explanatory variable. Those regressions are:

$$\text{Primary: } \text{Log (E coli)} = 1.57 * \text{log (Turbidity)} - 0.00238 * Q \text{ Pct} - 1.03 \quad [\text{MSE} = 0.312; R^2=0.716]$$

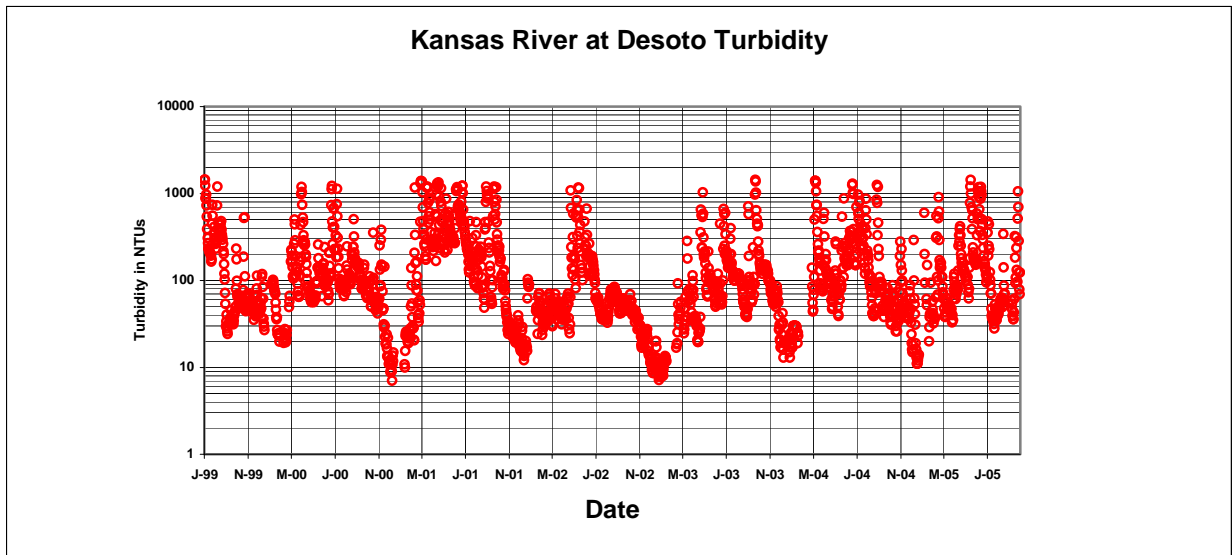
$$\text{Secondary: } \text{Log (E coli)} = 0.576 * \text{log (Turbidity)} - 0.01386 * Q \text{ Pct} + 1.743 \quad [\text{MSE} = 0.669; R^2=0.435]$$

All of these regressions yield relationships that follow a general pattern, but are marked by considerable variability around their predicted values (Figure 12). This limits the usefulness of the regressions to determine periods of exceedance and compliance relative to the two *E. coli* bacteria criteria for the river. However, qualitative relationships can be developed between bacteria counts, turbidity and flow percentile. For example, in Figure 12, at turbidity levels below 200 FTU, all but two *E. coli* samples were below the 262-count criterion. Between turbidity levels of 200-350 FTU, sample counts are split evenly on either side of the criterion and at turbidities over 350 FTU, all but one sample is definitely over the 262-count criterion. Hence, high (>350 FTU) turbidities are correlated with high bacteria levels and digressions over the 262-count criterion can be expected.

By similar measure, *E. coli* samples are below the criterion at low flow conditions (exceeded 60% of the time or more) (Figure 13). Conversely, samples are always above the criterion when flows rise above flow values exceeded less than 25% of the time. During secondary contact recreation season, samples taken when turbidities are below 100 FTU did not exceed the 2358-count criterion (Figure 14). Samples straddle the criterion at turbidities between 100 and 150 FTU and are predominantly above the criterion at turbidities above 150 FTU. Relative to flow condition, samples taken at low flow (> 65th percentile flow) did not exceed the criterion, whereas, samples collected at high (upper decile (10%)) flow remained above the criterion (Figure 15).

From these relationships, an algorithm was developed to evaluate the USGS continuous daily turbidity data. Values were assigned to each day based on the flow condition and turbidity recorded on that day. Days during April - October with flows lower than the 60th percentile flow were assigned a 0 value, indicating high bacteria levels were not likely. For those days with higher flows, if turbidity readings were below 200, a zero value was also assigned. If the turbidity values lay between 200 and 350, a value of 1 was assigned, indicating that high bacteria levels were a possibility. Finally, if turbidities over 350 were recorded, the day was assigned a value of 2, signifying bacteria levels were likely to be over the primary recreation criterion. Similar logic was applied to the secondary recreation season, using the 65th percentile flows and turbidities of 100 and 150 as value thresholds.

Figure 11. Daily Turbidity Values at Kansas River near Desoto (July 1999-Oct 2005)



The resulting analysis indicates several periods where non-point sources are likely to contribute sufficient loadings to allow bacteria levels to create an impaired condition on the Lower Kansas River (Figure 16). Elevated bacteria appear most prevalent during the historic runoff period between April and July. Secondary recreation season tends not to see much impairment except in March when runoff events begin to occur. Wet years such as 2004 and 2005 will see impairment episodes extend into the prime recreation season between July and September. Therefore, while monitoring under the “5 samples within 30 days” provision of the water quality standards may miss many impairing events along the river, evidence provided by turbidity measurements at Desoto suggests the river becomes impaired during runoff events.

Figure 12. Predicted Primary Recreation E coli Levels Based on Turbidity and Flow Condition

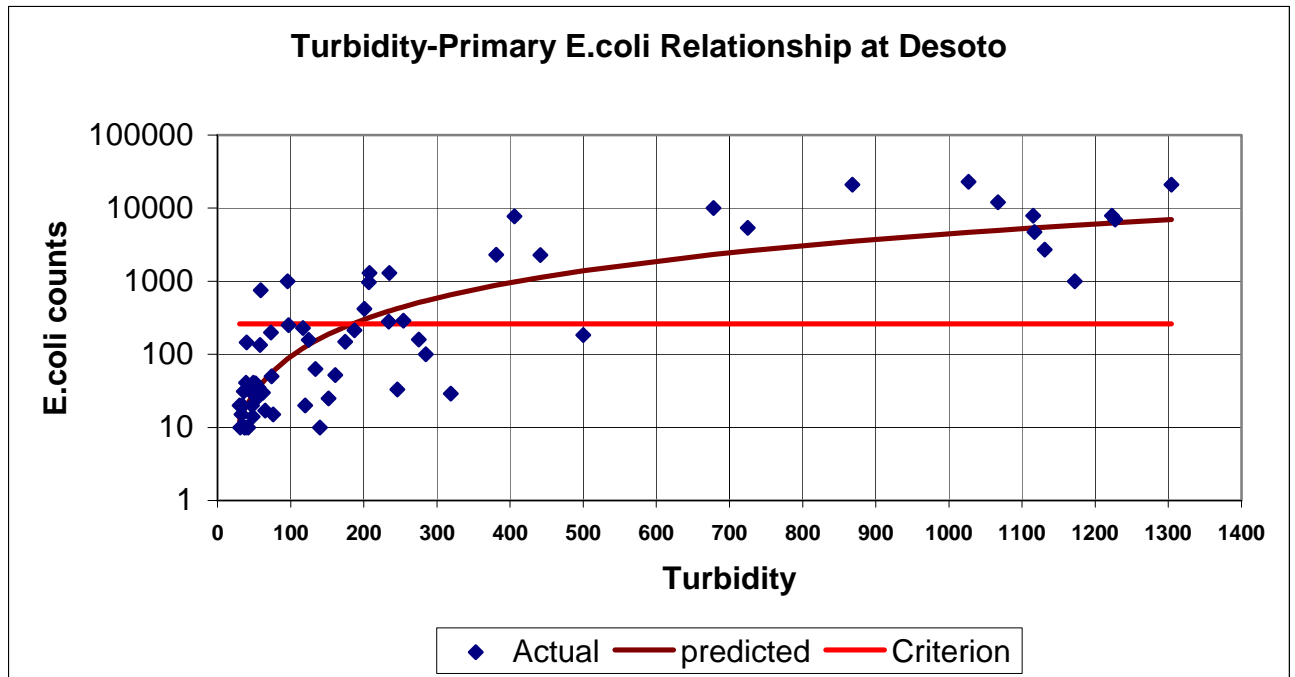


Figure 13. Flow Distribution of Primary Recreation Season E coli Levels at Desoto

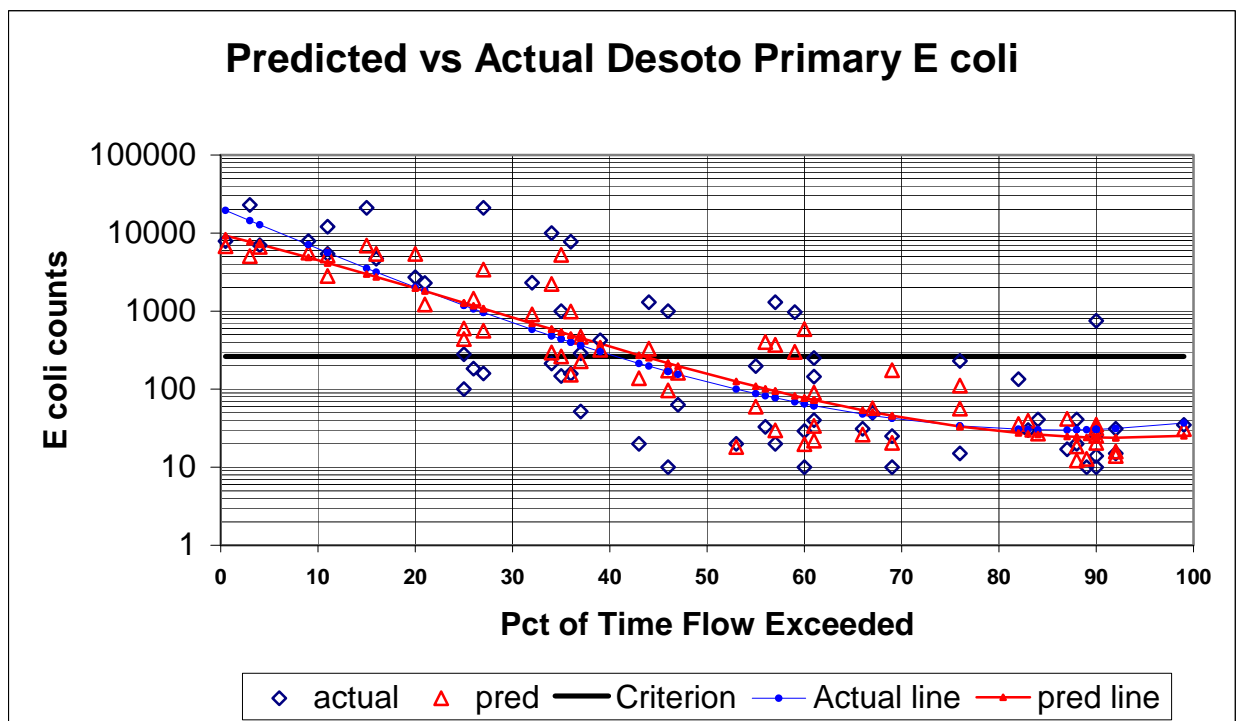


Figure 14. E. coli Relationship with Turbidity during November – March Periods at Desoto

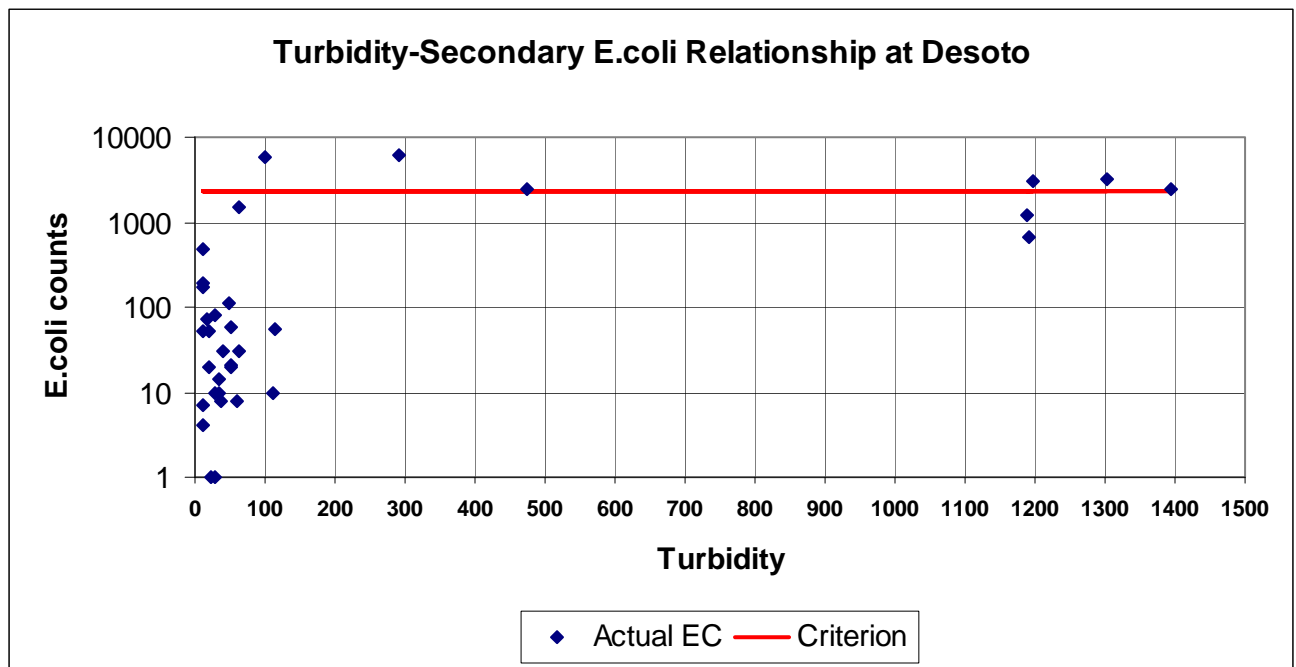
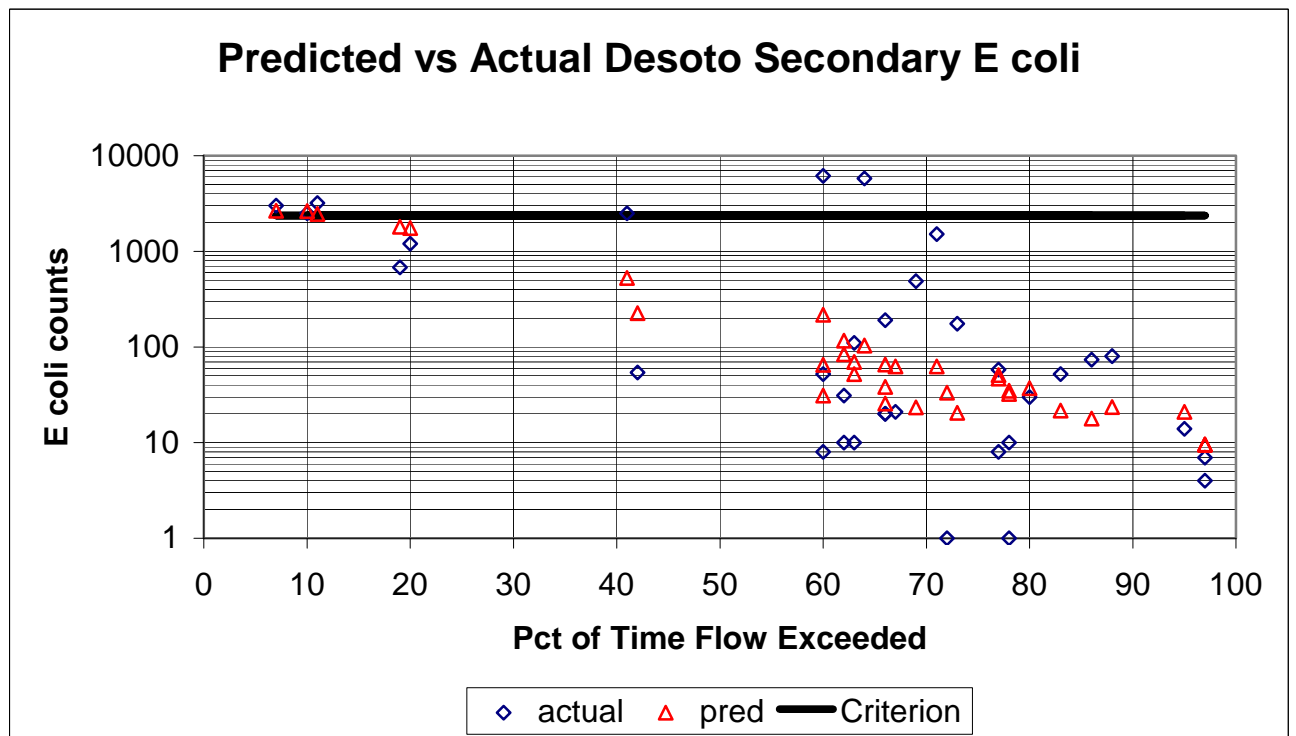


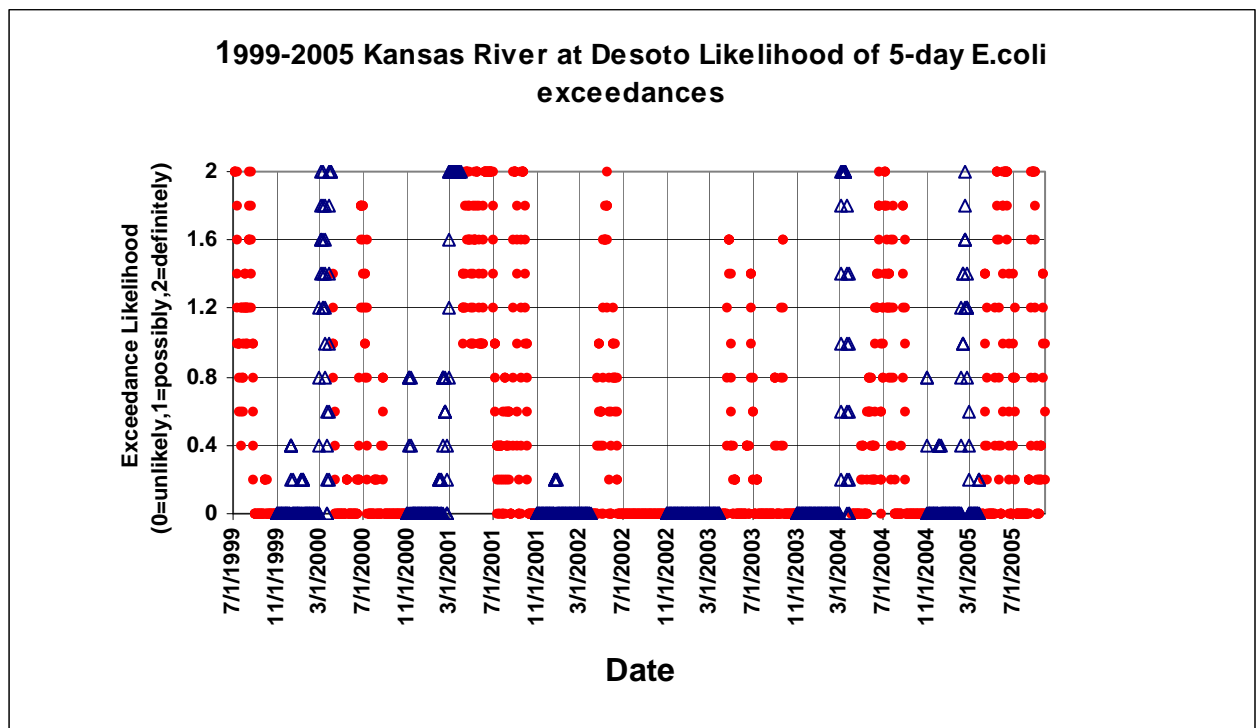
Figure 15. Flow Distribution of E coli during Secondary Recreation Season at Desoto



Evaluation of the turbidity flags for indicating primary recreation impairment was made through examining combinations of five samples with varying bacteria levels (10, 100, 250, 500, 1000 & 10,000 counts). The counts were assigned flag values (10=0; 100 & 250=1; 500, 1000 & 10000=2) and average flag values were computed for the various combinations of five. Overall, combinations with an average flag value below 1.2 did not exceed the 262-count criterion. Those combinations with average flag values lying between 1.2 and 1.4 sometimes exceeded the criterion, while those with averages greater than 1.4 invariably exceeded the criterion.

The daily record of turbidity flags from 1999 to 2005 was evaluated three ways to reflect the sampling requirements of the water quality standards (at least 5 samples, separated by 24 hours, all collected within 30 days). First, a rolling five-day average was used to represent the most intensive (average of 5 samples in 5 days) assessment approach in detecting impairments.

Figure 16. Estimated Indications of High Bacteria at Desoto through Turbidity Levels



Second, a rolling 30-day average was used to represent a more dampened (average of 30 samples taken in 30 days) assessment in detecting impairment. The third evaluation selected five samples, each separated by 7 days, representing weekly sampling (likely the sampling method envisioned by the standard). This evaluation also moved with each day of data. Figures 17-19 display the results of the three evaluation approaches across flow

conditions. As expected, the continually rolling 5-day averages show the highest likelihood of impairments occurring at high flows (Figure 17). The 30-day average produced lower likelihood of high bacteria levels (Figure 18). The weekly sampling scenario broke the continuity of single events (Figure 19) and lowered the magnitude of bacteria levels, although the frequency of impairment was greater than that of the rolling 30-day average. Table 4 displays the distribution of bacteria “hits” (values of 1.4 or more) and “passes” (values less than 1.4) over flow conditions for the three sampling approaches.

Depending on assessment method, 6-16% of the sampling periods were hits and 40-50% of the hits occurred at flows higher than mean daily flow (0 to ~20 percentile flows). Clearly, most recreation impairments are associated with large runoff events, while there is a strong degree of compliance during moderate and low flows, which are the periods when recreation is most likely to occur.

Figure 20 displays the secondary recreation season analysis and distribution of high bacteria likelihood during November to March over flow conditions, using the 5 samples in 30-day approach. There is less likelihood of encountering criterion exceedances in winter, because of lower runoff, less favorable stream environments and the 9-fold increase in criterion value.

Figure 17. Distribution of 5-Day Average Bacteria Levels at Desoto Over Flow Conditions

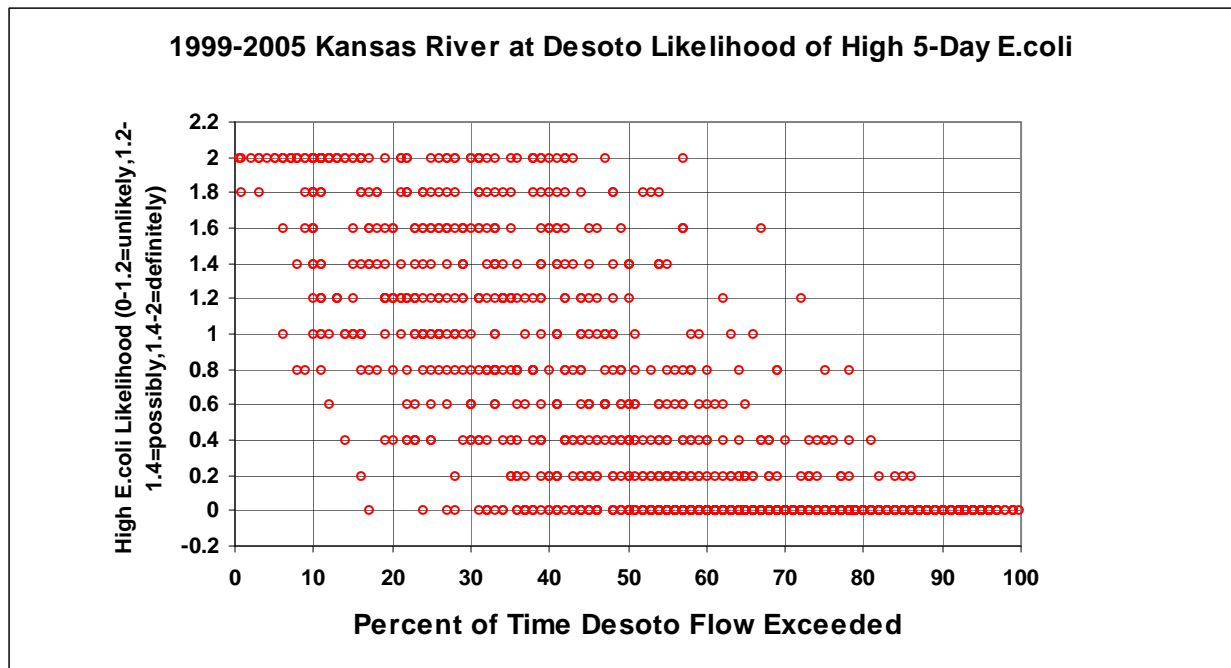


Figure 18. Distribution of 30-Day Average Bacteria Levels at Desoto Over Flow Conditions

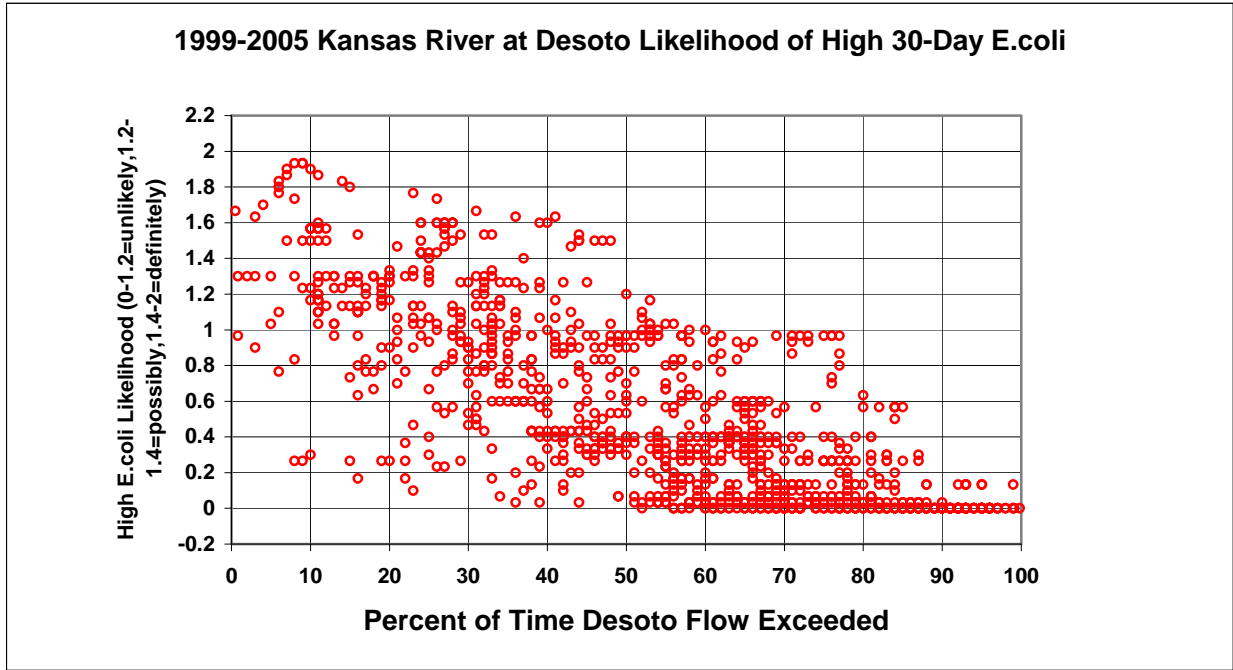


Figure 19. Distribution of Average 5-in-30-Day Bacteria Levels at Desoto Over Flow Conditions

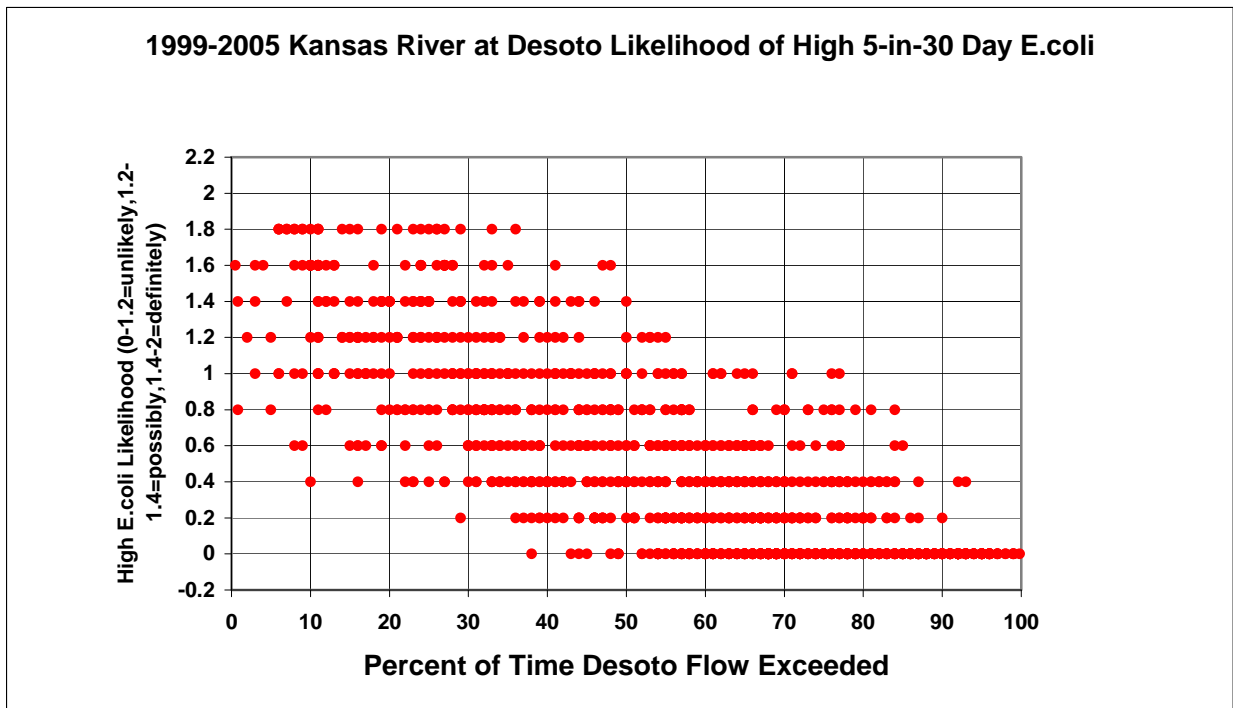


Figure 20. Distribution of Average 5-in-30 Bacteria Levels at Desoto During Nov-March Flows

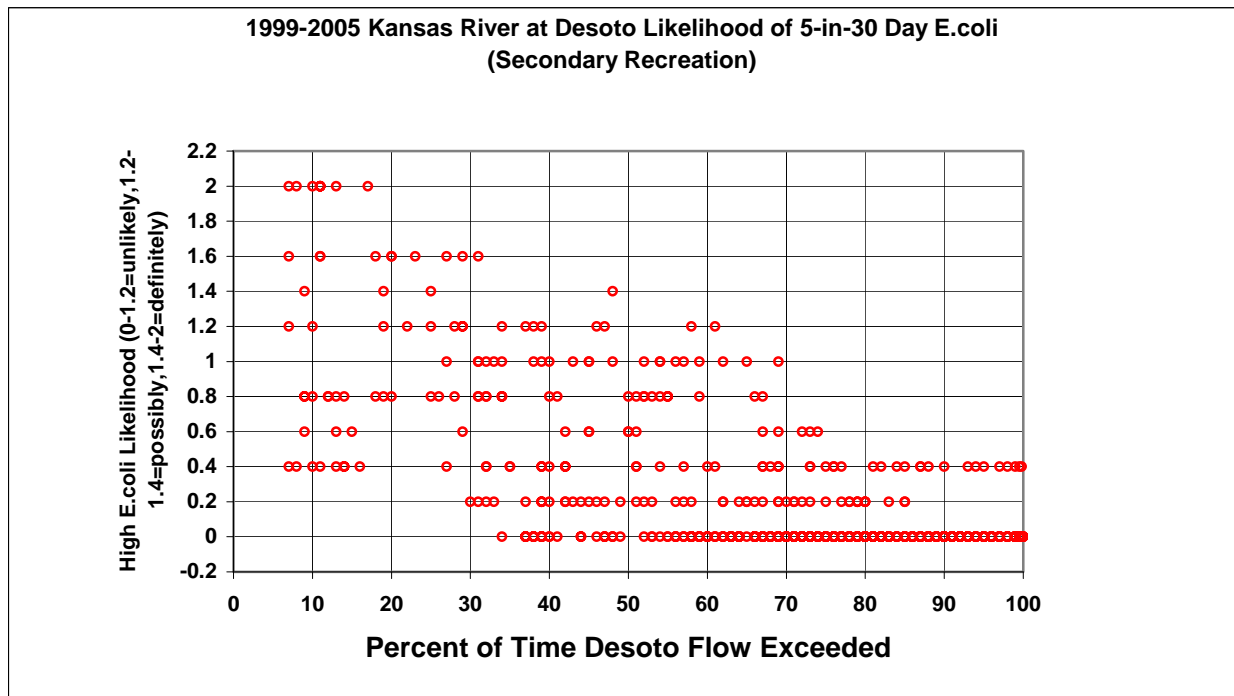


Table 4. Distribution of Primary Season Bacteria Hits & Passes at Desoto over Flow Conditions

	FLOW CONDITION-----										
Approach	0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%	Total
5-day Hits	39	49	45	41	25	11	1	0	0	0	211
5-day Passes	5	37	67	88	114	180	238	178	124	106	1137
30-day Hits	20	12	28	7	8	0	0	0	0	0	75
30-day Passes	17	62	63	107	110	161	211	152	123	92	1098
5-in-30 Hits	24	33	33	13	9	0	0	0	0	0	112
5-in-30 Passes	13	41	59	101	111	163	212	153	123	92	1068

Interim Endpoints of Water Quality (Implied Load Capacity) at Sites 203, 254, 255 & 257 over 2006 - 2010:

Overall, the endpoint for all sites subject to this TMDL will be to reduce the frequency of elevated bacteria levels in order to ensure that geometric means of samples taken in 30-day periods will remain below 262 counts from April to October and 2358 counts

between November and March. Geometric mean sampling in 2006 indicated impairment on the river at Lecompton and Kansas City, relative to current Water Quality Standards. Bacteria levels are likely to improve as disinfection requirements are installed on upgraded wastewater treatment facilities, long-term CSO control plans are implemented in Kansas City and stormwater Best Management Practices are installed in tributary watersheds.

Estimated bacteria levels from continuous turbidity monitoring indicate probable periods of impairment during runoff periods, typically during April to July. Some impairment of the secondary recreation season may occur in March as runoff conditions develop. This TMDL should first ensure that no impairments occur under flow conditions less than the long term mean daily flow. This assurance that bacteria are not an impediment to recreation during normal and low flows coincides with the higher probabilities of recreation use during those periods. Successful abatement of bacteria loadings under major runoff conditions, with flows exceeded less than 30% of the time will be more fleeting. However, sufficient watershed treatment of bacteria sources should reduce their loadings such that frequency of criterion exceedances at those flows decreases with time.

Seasonal variation in endpoints is accounted for by the bifurcation of the recreation season into primary (April through October) and secondary (November through March) periods. Seasonality is really expressed through prevailing flow conditions, with runoff occurring predominantly from March to July, summer baseflow from August to October and winter baseflow from November to February.

The following endpoints are the goals of this TMDL for the period 2006-2010. The endpoints will be evaluated, following assessment of monitoring data collected during this period, with a goal of declaring the Lower Kansas River to be in Category 2 (attaining some of its designated uses, in this case, recreation use) for the 2012 303(d) listing cycle.

1. Geometric means of E. coli bacteria at all four stations will remain below 262 counts during the April to October period.
2. Geometric means of E. coli bacteria at all four stations will be below 2358 counts during November to March.
3. Bacteria levels at Station 203 in Kansas City will decrease such that its geometric mean will be within the range of values seen at the three upstream stations.

These endpoints will be reached as a result of expected reductions in loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL. Achievement of the endpoints indicate loads are within the loading capacity of the stream, water quality standards are attained and full support of the recreation use of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are several NPDES permitted facilities discharging wastewater directly into the Kansas River or below tributary monitoring sites (Figure 21). Table 5 lists the discharging municipal and industrial facilities that potentially contribute bacteria. Nearly all of the facilities have installed disinfection treatment in their operations and have fecal coliform bacteria limits established under their NPDES permits.

The Johnson County Mill Creek Regional Plant is undergoing upgrades that will increase its average effluent rate to 18.75 MGD. The upgrade will replace the existing treatment system with a 6-Cell Aerated Lagoon and an Activated Sludge System with Ultraviolet Disinfection. The final permit limitations will be applied to the combined effluent and will be 1316 colonies per 100 ml on a monthly average from April to October and 2468 colonies from November to March. Unlike most municipal facilities, this plant utilizes a mixing zone for bacteria. The system will use a diffuser in the river to disperse the effluent and dilute the wastewater levels to water quality standards beyond its mixing zone. The upgrade was completed in July, 2006 and is now online.

The Desoto facility is being replaced with a 1.3 MGD Aerated Activated Sludge Process with Ultraviolet Disinfection that will discharge directly to the Kansas River (NPDES # KS0098167; Kansas Permit No.M-KS12-OO03, effective August 1, 2005 to December 31, 2008). Fecal coliform bacteria limits will continue to be 200 and 2000 colonies for the respective primary and secondary recreation seasons. The new plant is expected to go online in April 2007 and meet its final permit limits in May.

Plant No.14 in Wyandotte County is undergoing upgrades including installation of disinfection treatment, with the expectation that the 200/2000 permit limits would be met by November 2006.

The Lawrence facility has the capacity of treating extraneous flow, up to 40 MGD, with chlorination. When the extraneous flow system is discharging, monitoring of the facility effluent is on a daily basis. The Nelson Complex facility in Johnson County similarly handles extraneous flows through several holding basins in Turkey Creek and nearby drainages, which divert sewer system overflows during wet weather and treat that wastewater prior to discharge into Turkey Creek and other small streams. Sampling of Turkey Creek is a condition of permitting these high flow discharges. Bonner Springs has capacity to handle wet weather flows through its treatment plant. Discharges from extraneous flow basins are typically disinfected before entering the stream system.

Examination of Discharge Monitoring Reports for 2003-2005 at these facilities reveals no problems at Perry, Lecompton, Lawrence, Westar, Clearview Village, Eudora or Bonner Springs. The two Sewer Districts in Leavenworth County did not discharge during the period. Other facilities such as Basehor, Gardner, and Olathe, discharge to streams that are monitored by KDHE stations.

Desoto had elevated bacteria levels in its effluent numerous times in the last three years, although levels in early 2005 were compliant and a marked improvement over the constant violations seen in 2003.

Table 6 lists the geometric means for various periods for the major dischargers to the Kansas River in Johnson and Wyandotte Counties. Disinfection at Kansas City Plant #20 appears to be effective and effluent quality at the Johnson County Nelson Complex has improved since 2003. Johnson County's Mill Creek Regional Plant has had consistently elevated bacteria, those levels should decline with the completion of upgrades at the plant. The numbers at KC Plant #14 are quite high, fortunately the volume of effluent is small, but it is apparent that the ongoing upgrades are necessary to achieve water quality standards. Figure 22 confirms that Plant #20 and Nelson have performed well relative to permitted limits, while the other two plants need disinfection treatment to meet permit limits.

General permits are in various stages of development regarding municipal separate storm sewer system (MS4) discharges of stormwater. Along the lower Kansas River, MS4 permits have been in place since 2004 and are slated to run through September 30, 2009. Lawrence (M-KS31-SU01; KSR041014), Shawnee (M-KS68-SU01; KSR041033), Merriam (M-KS44-SU01; KSR041019), Mission (M-KS45-SU01; KSR041021), Johnson County (M-KS52-SU02; KSR041007) and Bonner Springs (M-KS06-SU01; KSR041003) have MS4 permits in place that reference high priority TMDLs and direct installation of Best Management Practices to attenuate the discharge of those pollutants. Olathe (M-KS52-SU01, KSR041025) and Lenexa (M-KS34-SU01; KSR041016) deliver stormwater to the Kansas River via Cedar and Mill Creeks.

Additionally, the Unified Government of Wyandotte County, encompassing Kansas City, has a MS4 NPDES permit (M-MO25-SO01; KS0095656) for stormwater discharges to both the Kansas and Missouri Rivers. The NPDES permit for the Kaw Point WWTP facility discharging to the Missouri River (M-MO25-IO01; KS0038563) also has provisions to develop, implement and update its Combined Sewer Overflow Long-Term Control Plan. This plan addresses wet weather discharges to the Kansas River and its urbanized tributaries in the County (Mattoon Creek and Muncie Creek) with long term planning, investment and construction for separating sewers, retention of overflows and disinfection of overflow discharges before entering the Kansas River and its tributaries. The permit and the CSO provisions are now under administrative extension and process for renewing the permit is in coordination between KDHE, EPA and the Unified Government, including issues of Missouri CSO's discharging to the Kansas River.

Overall, about 29% of the drainage in the Lower Kansas River Subbasin is covered by these MS4 NPDES permits.

Table 5. Bacteria Dischargers to Kansas River from Delaware River to Mouth

Facility	NPDES #	State #	Type	Receiving Stream	Design Flow	Bacteria Monitoring	FCB Limit	Permit Expires
Perry	KS0029084	M-KS58-OO01	3-Cell Lagoon	Delaware River	0.11165	Annually	535/4800	9-30-2011
Lecompton	KS0055581	M-KS33-OO01	3-Cell Lagoon	Kansas River	0.0713 MGD	Monthly	Monitor Only	11-30-2011
Westar-Lawrence	KS0079821	I-KS31-PO09	Package Plant w/ Ozone	Kansas River	1.2 MGD	Bimonthly	200/2000	12-31-2007
Lawrence	KS0038644	M-KS31-IO01	Activated Sludge w/ Chlorination	Kansas River	12.5 MGD	Weekly	200/2000	12-31-2008
Eudora	KS0094609	M-KS17-OO02	Activated Sludge w/ UV	Wakarusa River	0.9 MGD	Monthly	200/2000	8-31-2011
Clearview Village	KS0090671	C-KS12-OO01	3-Cell Lagoon	Kill Creek	0.056 MGD	Annually	Monitor Only	9-30-2011
Desoto *	KS0026239	M-KS12-OO01	Oxidation Ditch w/ UV	Kill Creek	0.4 MGD	Weekly	200/2000	3-31-2011
Bonner Springs	KS0082881	M-KS06-OO02	Activated Sludge w/ UV	Kansas River	1.4 MGD	Weekly	200/2000	9-30-2011
LV Co SD#2	KS0087157	M-KS06-OO03	3-Cell Lagoon	Wolf Creek	0.072 MGD	Annually	535/4800	9-30-2011
LV Co SD#3	KS0087874	M-KS04-OO05	3-Cell Lagoon	Wolf Creek	0.018 MGD	Annually	4800	9-30-2011
JO Co – Mill Crk **	KS0088269	M-KS68-OO04	8-Cell Aerated Lagoon	Kansas River	9.0 MGD	Weekly	1316/2468	8-31-2008
KC - #20	KS0080195	M-KS27-RO20	Activated Sludge w/ UV	Kansas River	7 MGD	Weekly	200/2000	12-31-2011
KC - #14	KS0080209	M-KS27-RO14	Oxidation Ditch	Kansas River	0.12 MGD	Monthly	200/2000	12-31-2011
JO Co - Nelson	KS0055492	M-KS45-OO01	Trickling Filter w/ UV	Turkey Creek	15 MGD	3X/Week	200	9-30-2006

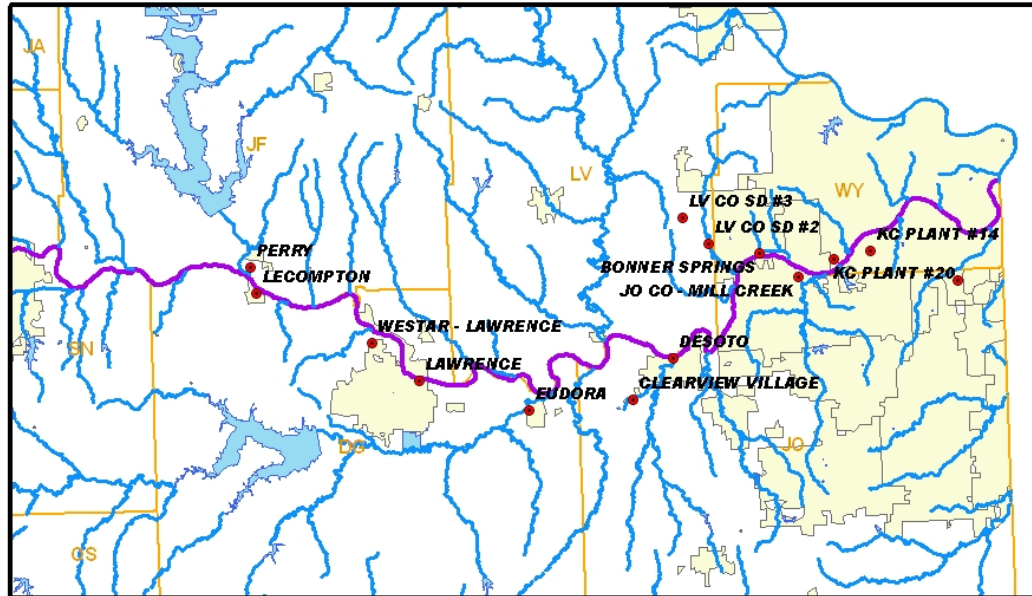
* New Plant: 1.3 MGD, activated sludge and ultraviolet disinfection to come online April 2007, will discharge directly to Kansas River with permit limits of 200/2000

** Plant Upgrade: 18.75 MGD, combined 6-cell lagoon and activated sludge and ultraviolet disinfection with a in-river diffuser to come online in summer 2006.

Permit Limits are expressed as geometric means

Figure 21. Location of NPDES Facilities Along Lower Kansas River

NPDES Facilities Along Lower Kansas River



Legend

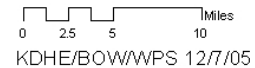
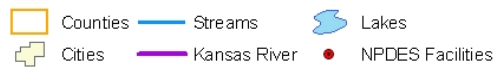
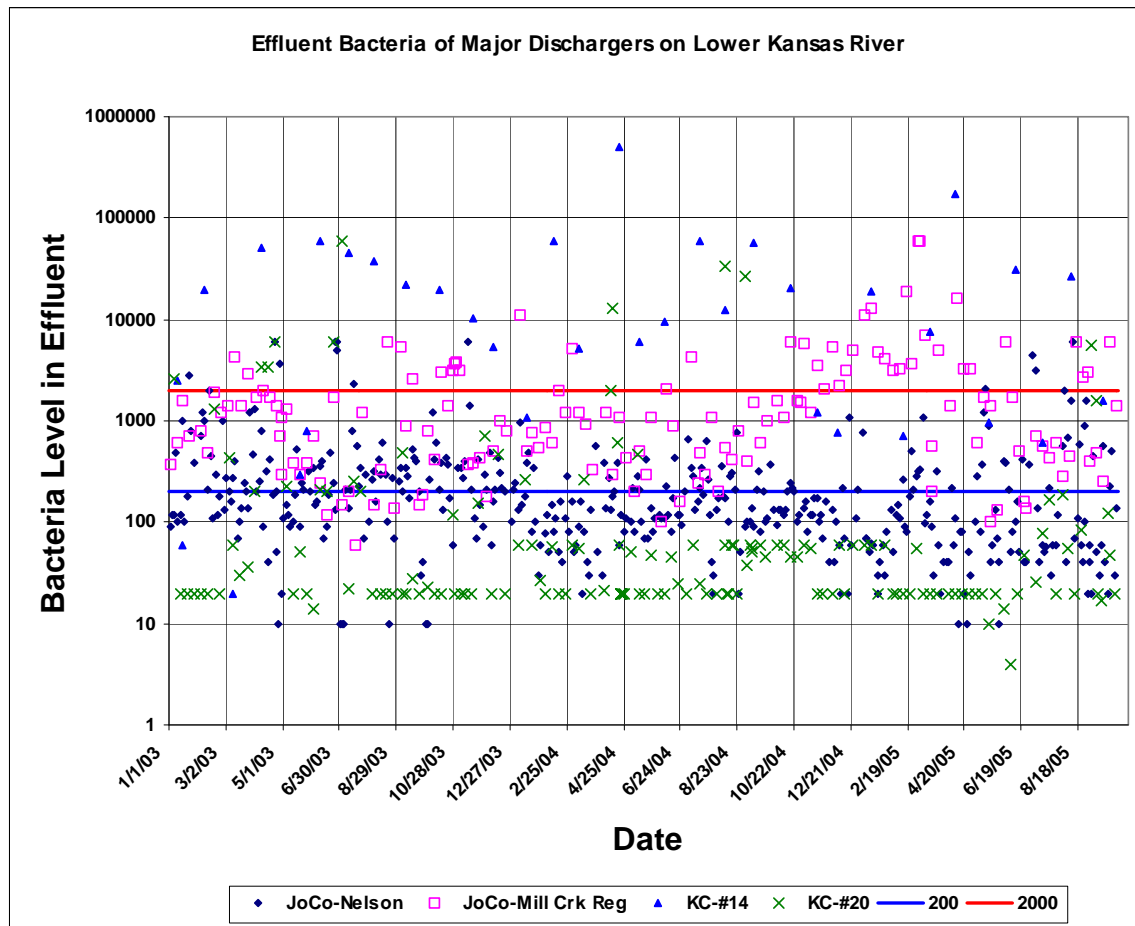


Table 6 Geometric Means of Bacteria from Major Dischargers in Johnson & Wyandotte Counties

Period	Nelson	Mill Crk	Plant #14	Plant #20
2003	230	770	4565	86
2003 Primary	205	712	12275	106
2004	127	985	11888	59
2004 Primary	144	680	30741	68
2005	115	1690	6216	37
2005 Primary	121	930	7182	41
2003-2005	154	1048	6861	59

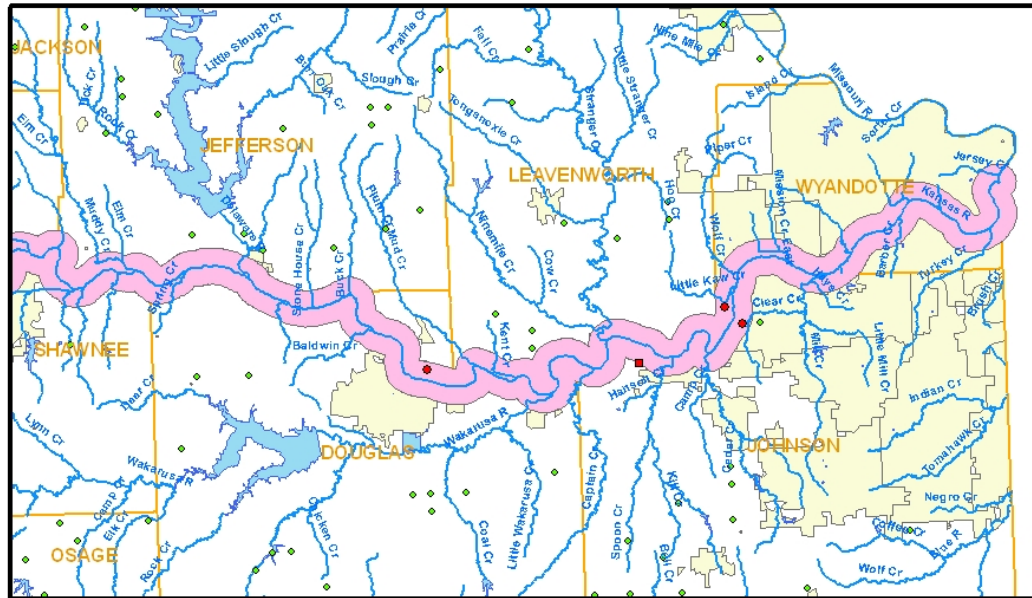
Figure 22. Bacteria Levels in Effluent from Major Dischargers to Lower Kansas River



Livestock Waste Management Systems: While numerous state or Federal permitted facilities lie within the Lower Kansas Subbasin (Figure 23), there are only four facilities within a one-mile corridor of the river itself. These four facilities are state certified or permitted through the KDHE Livestock Waste Management Program (Table 7). Two of the facilities are small and certified not to be significant potential to pollute the Kansas River. Manure and waste are dispersed over cropland for one of the permitted facilities in accordance with a management plan. The largest facility has a lagoon system for full retention of runoff from the operation. Therefore, impacts from these facilities are minimized through compliance with their permit conditions and any incidental discharges too localized for detection through the ambient stream network. Livestock impacts to the river more likely occurs from runoff over open pasture within the watershed and accumulated contributions flowing down from tributaries.

Figure 23. Location of Animal Feeding Operations Along Lower Kansas River

CAFOs Along Lower Kansas River



Legend

- Counties
- Cities
- One Mile Buffer
- Streams
- Lakes
- CAFOs
- Beef
- Beef, Swine, Sheep, Horse



0 2.5 5 10 Miles

KDHE/BOW/WPS 12/2/05

Table 7. Animal Feeding Operations within One Mile of Lower Kansas River

Permit No.	County	Nearby City	Animal Units	Type	Animal Type	Certificate Issued or Permit Expires
A-KSJO-BA02	Johnson	Shawnee Mission	25	Compliance Certification	Beef	11/25/1996
A-KSWY-BA01	Wyandotte	Bonner Springs	175	Compliance Certification	Beef	4/30/2001
A-KSJO-BO01	Johnson	Desoto	949	State Permit	Beef, Swine, Sheep, Horse	8/14/2008
A-KSDG-BO02	Douglas	Lawrence	850	State Permit	Beef	6/7/2009

Land Use: Most of the watershed is grassland (41% of the area), cropland (36% of the area), urban (9% of the area) or woodland (15% of the area). Grazing density of livestock is low for the Kansas/Lower Republican basin (25 animal units/sq. mi.).

On-Site Waste Systems: The population density in the watershed is high owing to the vicinity of development around the Kansas City metropolitan area. Rural population projections for Johnson and Wyandotte counties show decreases over time as annexation of rural areas by municipalities ensues. Populations in rural areas of Leavenworth County through 2020 show significant increases in population. While failing on-site waste systems can contribute bacteria loadings, their impact on the Kansas River, given the magnitude of river flows will be minimal. Excursion from the water quality standards is probably more significant on the minor tributaries of first or second order streams than on the major tributaries or the main stem of the Kansas River.

Background Levels: Some fecal bacteria counts may be associated with environmental background levels, including contributions from wildlife, but it is likely that the density of animals such as deer is fairly dispersed across the watershed resulting in minimal loading to the streams below the levels necessary to violate the water quality standards.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The Wasteload and Load Allocations will reflect requirements within the Water Quality Standards regarding bacteria levels. It is apparent that different mechanisms contribute bacteria during baseflow and runoff conditions. Generally, point sources will be responsible for maintaining the ability of the Lower Kansas River to support contact recreation during low flows. Stormwater sources in both urban and rural settings will be responsible with maintaining adequate bacterial quality in the river during higher flows within the reasonable expectation of effectiveness for Best Management Practices applied to abate waste loading to the river.

Point Sources: In accordance with the Surface Water Quality Standards at K.A.R. 28-16-28e(c)(7)(F), “Wastewater effluent shall be disinfected if it is determined by the department that the discharge of non-disinfected wastewater constitutes an actual or potential threat to public health”. Therefore, wastewater released through facilities under NPDES permits will either be disinfected at mechanical plants or with lagoons, have been retained for a reasonable amount of time to ensure bacteria die-off prior to discharge. Most of the facilities discharging to the Lower Kansas River are now undergoing disinfection. The remaining facilities in Johnson and Wyandotte Counties are undergoing upgrades to install disinfection prior to discharge to the river and should be fully operational within the first year of this TMDL.

The Wasteload Allocations will reflect the applicable permit limits of a number of colonies of bacteria per 100 ml for most of the facilities at their outfall to the river. Typically, these limits are 200 colonies during April through October and 2000 colonies during November through March. In a few cases, some use of the mixing zone within the Kansas River is utilized for the final permit limits placed on certain facilities for bacteria. Additionally, a few facilities have received a limit that is a translation to Fecal Coliform Bacteria from the *E coli* bacteria criteria in the Kansas River. Regardless, with the installation of treatment system upgrades, there should be no point source induced excursions from the bacteria criteria in the Lower Kansas River, except in cases of plant

upset. Low flow support of recreation in the river should be attained. The individual Wasteload Allocations for each facility are enumerated in Appendix A. Wasteload Allocations comprise the incremental increase in loads between Lecompton and Kansas City until flow conditions surpass the 80th percentile flow.

Phase I and II Stormwater Permits issued to MS4's in the portions of the watershed in Johnson, Wyandotte, Leavenworth or Douglas counties will reference the need to apply specific Best Management Practices to attenuate the discharge of bacteria whenever stormwater drains to the Lower Kansas River, either directly or via tributaries. While no specific numeric limits will be attached to these stormwater permits, there is a WLA assigned to the aggregate of urban MS4 stormwater influencing water quality in the Lower Kansas River. The WLA for the MS4's will be based on the proportion of runoff-driven bacteria loads that likely arise from the developed areas covered by the MS4 permits. In this case, 1226 square miles are monitored between Lecompton and the mouth of the Kansas River at Kansas City. MS4 areas comprise 28% of the drainage of the Lower Kansas River. Therefore, 29% of the seasonal Load Duration Curves in Appendix B, after accounting for the regular WLA for dischargers, represents the aggregate WLA for stormwater. The balance is the Load Allocation for non-point sources.

That stormwater WLA is based on the current water quality standards and criteria regarding bacteria in streams. In this case, geometric means of 262 counts per 100 ml from April to October will be maintained within 30-day periods after the initial stormwater event. Similarly, geometric means of 2358 counts per 100 ml from November to March will be maintained within 30 days of a storm event. Monitoring should occur on a weekly basis starting no later than the day after the first event to ensure five samples are collected within the 30-day post-event period. Adherence to the geometric mean allows for occasional spikes of bacteria generated by first flush runoff events to be offset by subsequent resumption of low bacteria concentrations within a finite time. Priority should probably be directed toward Mill Creek. Mill Creek is a highly urbanized watershed in Johnson County, where urban stormwater is likely to deliver high bacteria loads to the Kansas River. Stormwater management along urbanized areas of Cedar Creek and Kill Creek will also benefit the Kansas River.

The Combined Sewer Overflows in Kansas City and Wyandotte County are a portion of the MS4 WLA assigned to that municipality and will be addressed through ongoing implementation of the Long Term Control Plan, with disinfection of discharges to river expected over time. The WLA assigned to this aspect of the Unified Government/Kansas City NPDES permit will be also be based on the applicable geometric mean of the bacteria criteria applied over a 30-day period with subsequent post-discharge monitoring. Implementation activities relative to this TMDL should probably be directed toward the western-most outfalls to the Kansas River in order to progress favorable conditions in a downstream direction.

Any animal feeding operations with sufficient animal units (>1000) to warrant a NPDES permit will have full containment of their wastewater as a condition of the permit,

therefore, the Wasteload Allocation for any such operation is effectively zero.

Non-Point Sources: Based on the assessment of bacteria conditions in the Lower Kansas River, flows that are exceeded more than 60% of the time tend to indicate no problem with elevated bacteria. Runoff conditions introduce higher probabilities of bacteria excursions in the river, particularly once flows reach the level where they are exceeded less than 20% of the time. As calculated in Appendix B, Load Allocations for non-point sources represent 71% of the seasonal Load Duration Curve after accounting for discharging NPDES facilities and their WLA. The balance is allocated to MS4 WLAs. The Load Allocation to non-point sources is to eliminate any excursions by geometric means occurring in the river at flows less than the mean daily flow that is typically exceeded less than 20 percent of the time. Exceedances at the highest flows exceeded less than 20% of the time should be minimized such that they occur in less than 10% of the sampled periods. Abatement practices at these highest flows will be limited in their hydraulic ability to affect runoff and the spatial density of such practices over the watershed is unlikely to reach a level that regionally generated streamflows will be effectively treated. Nonetheless, this Load Allocation will be effective in abating bacteria during periods of most probable recreation use in the river.

The Load Allocation also needs to assign responsibility to abate bacteria loadings among the tributaries to the Lower Kansas River. Based on concurrent sampling, the highest priority tributary watershed should be Stranger Creek. Stranger Creek is a large rural watershed with the highest density of livestock within the Lower Kansas Subbasin. While Mill Creek has a high propensity for urban stormwater, any activities within that watershed that lie outside the purview of MS4 permits should be addressed with appropriate Best Management Practices for reducing bacteria loads. Both of these watersheds have existing bacteria TMDLs from 1999, as do Cedar Creek, Kill Creek and the Lower Wakarusa River. These TMDLs, although not modified to reflect current Surface Water Quality Standards regarding bacteria, remain in force and should continue to direct Best Management Practices to abate bacteria in rural and urban areas.

Defined Margin of Safety: The Margin of Safety will be explicit in that most facilities will have permit limits that apply at their outfall before entering the Kansas River. The requirements to disinfect wastewater remain in place regardless of streamflow condition. Therefore, there is limited allowance to use the river to dilute effluent in order to meet the criteria. The other aspect of this Margin of Safety is implicit in that achievement of the water quality standard is based on evaluating the geometric mean of five samples taken in 30 days. KDHE monitoring protocols will sample no more than 5 times (thereby, giving each sample maximum weight) and over period less than 30 days (thereby, maximizing the potential to sample similar flow conditions and events). Additionally, sampling will continue over all flow conditions, including the heretofore-compliant low flow conditions. This will ensure that the historic attainment of the recreation use at lower flows will continue.

State Water Plan Implementation Priority: Because this portion of the Kansas River coincides with the highest density of population within the river valley, because ongoing

work to upgrade facilities and wastewater systems is underway and because this is the first Kansas TMDL to convert from the historic Fecal Coliform Bacteria to *E. coli*, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Lower Kansas River (HUC 8: 10270104) with a priority ranking of 1 (Highest Priority for restoration work).

Priority HUC 11s and Stream Segments: The priority segments along the Kansas River will be Segments 1 and 2, where upgrades in treatment facilities will further disinfect wastewater entering the river. Priority watersheds for directing Best Management Practice installation will be Stranger Creek and Mill Creek. Streams and drains to the Kansas River in Kansas City should be a priority for the CSO Long Term Control Plan.

5. IMPLEMENTATION

Desired Implementation Activities

1. Complete installation of disinfection treatment at Desoto, Johnson County – Mill Creek Regional Plant and Kansas City Plant No. 14.
2. Implement subsequent phases of the Unified Government/Kansas City CSO Long Term Control Plan.
3. Minimize non-point source contributions of bacteria loading to the river via tributaries.

Implementation Programs Guidance

NPDES - Municipal Program - KDHE

- a. Complete facility upgrades and conditions of compliance with currently issued NPDES permits for the municipal treatment plants in Johnson and Wyandotte counties with disinfection requirements.
- b. Place conditions in Phase I and II Stormwater Permits for MS4's in Johnson, Wyandotte, Leavenworth and Douglas Counties to implement Best Management Practices that abate bacteria loading to the Kansas River and its tributaries via stormwater.
- c. Implement the Kansas City CSO Long Term Control Plan and incorporate disinfection of discharges from CSOs to the Kansas River.

Livestock Waste Management Program – KDHE

- a. Ensure facilities within one mile of the Kansas River are complying with their certificate or permit conditions that reduce their potential to pollute.
- b. Place appropriate permits on any new or modified operation in the vicinity of the river to reduce discharge of bacteria to the Kansas River or its tributaries including Stranger Creek, Mill Creek, Cedar Creek, Kill Creek and the Lower Wakarusa River.

Non-Point Source Pollution Technical Assistance – KDHE

- a. Support Section 319 demonstration projects for reduction of bacteria in runoff from grazing along the Kansas River and on the major tributaries to the river.
- b. Provide technical assistance on practices geared to establishment of vegetative buffer strips on smaller order streams leading to the Kansas River.
- c. Guide federal programs, such as the Environmental Quality Improvement Program & Conservation Security Program, to support installation of bacteria Best Management Practices to the grazing lands drained by the tributaries to the Kansas River.
- d. Establish a series of long-term Watershed Restoration and Protection Strategies for applicable watersheds in the Lower Kansas River Subbasin to comprehensively reduce the loading and delivery of bacteria, among other pollutants, to the river from its tributary watershed.
- e. Find opportunities to support projects directed at reducing urban stormwater and associated bacteria loads in Mill Creek and other urbanized watersheds.
- f. Support Local Environmental Protection Program efforts to improve on-site wastewater systems, particularly those in vicinity to the Kansas River.

Water Resource Cost Share & Non-Point Source Pollution Control Programs - SCC

- a. Support installation of bacteria management practices by agricultural producers along the Kansas River and its tributaries, emphasizing Stranger Creek.
- b. Support best management practices to minimize bacteria runoff associated with urban stormwater, but not required by NPDES permits.

Riparian Protection Program - SCC

- a. Establish or reestablish natural riparian systems, including vegetative filter strips along small tributaries
- b. Develop riparian restoration projects in pasture lands
- c. Support riparian restoration for streams in urban settings

Buffer Initiative Program - SCC

- a. Install grass buffer strips along small streams.
- b. Work in conjunction with federal Farm Bill program activities such as Environmental Quality Incentive Program to minimize livestock impacts to small streams leading to the Kansas River.

Timeframe for Implementation: Installation of disinfection treatment at municipal treatment plants should be complete by 2006-2007. Additional non-point source

pollution reduction practices should be installed along the Kansas River, small order streams leading to the Kansas River, and Stranger Creek and Mill Creek by 2011.

Targeted Participants: Primary participants for implementation will be municipal wastewater operators, stormwater managers, county conservation district personnel and county LEPP staff.

Some inventory of local needs should be conducted in 2006-7 to identify activities that contribute bacteria to the Kansas River. Such an inventory would be done via the WRAPS process by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs during the implementation period of this TMDL.

Milestone for 2011: The year 2011 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, disinfection at upstream point sources should be completed and adequate implementation of practices in rural and urban contributing areas should be complete.

Delivery Agents: Regarding point source treatment, KDHE staff in the Municipal Programs will oversee the appropriate permits, schedules of compliance and review of plans.

For the probable non-point sources, the primary delivery agents for program participation will be the conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension and agricultural interest groups such as Kansas Farm Bureau, Kansas Livestock Association, the Kansas Pork Producers Council and the Kansas Dairy Association. County staff managing Local Environmental Protection Programs for Johnson, Wyandotte, Leavenworth and Douglas counties will perform on-site waste system inspections.

Reasonable Assurances

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.
2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas

on a watershed basis.

4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control non-point source pollution.

6. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan.

8. K.A.R. 28-16-28e (c)(7)(F) requires wastewater effluent to be disinfected where it constitutes an actual or potential threat to public health.

9. The Kansas Water Plan and the Kansas-Lower Republican Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the Kansas Water Plan. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This TMDL is now a High Priority consideration and should receive funding for appropriate corrective and restorative activities after 2007.

The State Revolving Loan Fund is operated through the Municipal Program at KDHE and provides low interest loans for wastewater treatment improvement. Since its inception, \$750 million in loans have been made to municipal dischargers in the state.

Effectiveness: Improvements in reducing bacteria loading to streams can be accomplished through appropriate management and control systems for municipal wastewater, livestock waste and on-site waste systems. Disinfection techniques within mechanical treatment plans have been very effective in reducing bacteria levels within wastewater effluent. Use of ultraviolet lights reduces bacteria counts to less than 100 colonies per 100 ml.

6. MONITORING

KDHE will continue to collect bimonthly samples at Stations 203, 254 and 257, including E. coli samples over each of the three defined seasons. Based on that sampling, more intensive sampling of 5 samples taken within 30 days will occur over 2010-2012. Real time turbidity sensors at the Desoto stream gaging station will be re-installed during 2008-2010 to evaluate high flow bacteria levels and the stability of the regressions used to estimate E. coli bacteria levels from turbidity.

Monitoring of bacteria levels in effluent will be a condition of NPDES and state permits for the facilities discharging wastewater. This monitoring will continually assess the contributions of the wastewater systems, as well as the effectiveness in reducing bacteria levels in the effluent released to the river.

Monitoring protocols will be established as part of stormwater and CSO programs to capture bacteria levels with the first flush after a storm event and subsequent weekly sampling in order to compute a geometric mean in accord with current water quality standards.

7. FEEDBACK

Public Notice: Public notification of the second round of TMDLs in the Kansas-Lower Republican Basin was made in the Kansas Register in December 22, 2005. An active Internet Web site was established at <http://www.kdheks.gov/tmdl> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Kansas-Lower Republican Basin. Comments on the draft TMDL were received by the Johnson County Wastewater and Stormwater Programs.

Public Hearing: Public Hearings on the second round of TMDLs for the Kansas-Lower Republican Basin were held in Manhattan and Olathe on January 18 and 19, 2006.

Basin Advisory Committee: The Kansas-Lower Republican Basin Advisory Committee met to discuss the second round of TMDLs in the basin on April 7, 2005 in Lawrence, July 26, 2005 in Concordia, October 20, 2005 in Lawrence and January 26, 2006 in Topeka.

Milestone Evaluation: In 2011, evaluation will be made as to the degree of bacteria impairment that continues in the Lower Kansas River and the implementation activities that have occurred within the watershed. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The river will be evaluated for delisting under Section 303(d), based on the geometric means of monitoring data in 2010 and after. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list after the third round of TMDL activity begins in the Kansas-Lower

Republican Basin in 2011. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2007 which will emphasize revision of the Water Quality Management Plan and Watershed Restoration and Protection Strategies. At that time, incorporation of this TMDL will be made into applicable documents. Recommendations of this TMDL will be considered in Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2007-2011.

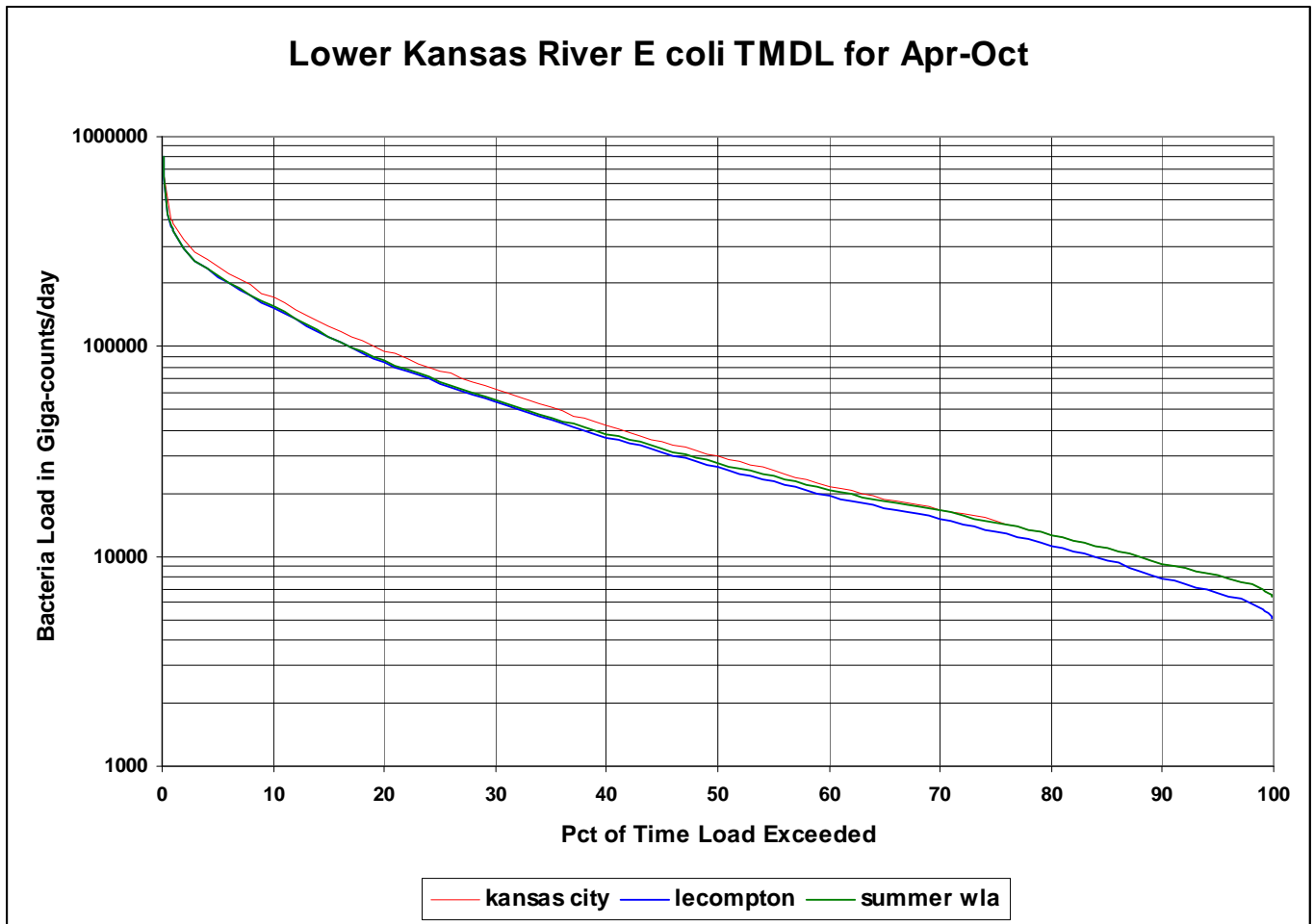
Revised November 19, 2007

Appendix A. Discharging NPDES Facilities and their Individual Wasteload Allocations

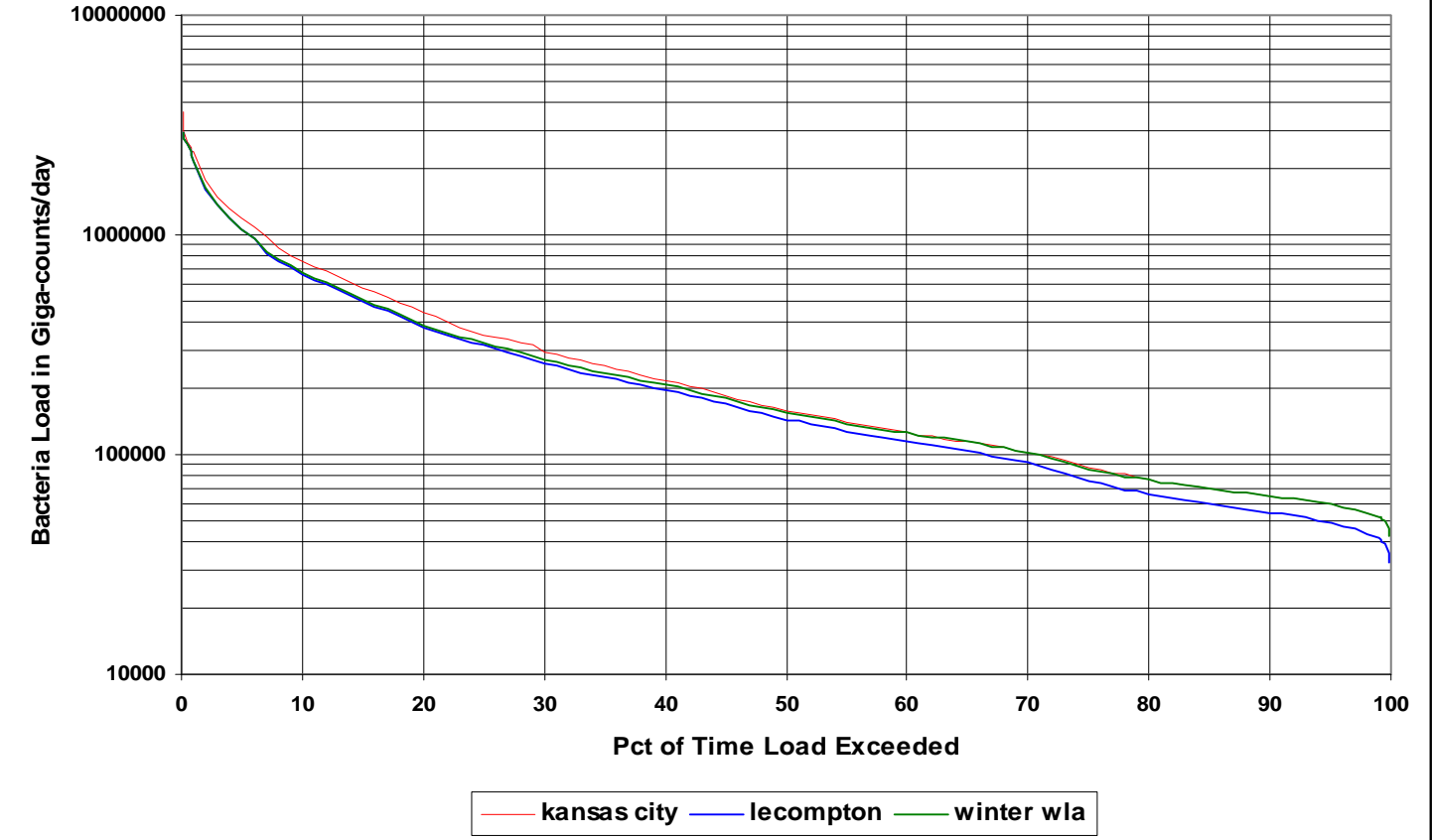
NPDES Facilities	NPDES #	Design Q (MGD)	Summer Limit	Winter Limit	Summer Load	Winter Load
Perry	KS0029084	0.11165	535	4800	2.26	20.28
Lecompton	KS0055581	0.0713	535	4800	1.44	12.95
Westar-Lawrence	KS0079821	1.2	200	2000	9.08	90.83
Lawrence	KS0038644	12.5	200	2000	94.62	946.16
Eudora	KS0094609	0.9	200	2000	6.81	68.12
Clearview Village	KS0090671	0.056	535	4800	1.13	10.17
Desoto	KS0026239	1.3	200	2000	9.84	98.40
Bonner Springs	KS0082881	1.4	200	2000	10.60	105.97
LV Co. S.D.#2	KS0087157	0.072	535	4800	1.46	13.08
LV Co. S.D.#3	KS0087874	0.018	4800	4800	3.27	3.27
JO Co. - Mill Creek	KS0088269	18.75	1316	2468	933.86	1751.34
KC - Plant #20	KS0080195	7	200	2000	52.98	529.85
KC - Plant #14	KS0080209	0.12	200	2000	0.91	9.08
Jo Co. - Nelson Plant	KS0055492	15	200	200	113.54	113.54
Total		58.5 MGD			1241.81	3773.05
		90.5 cfs	counts/100 ml	counts/100 ml	Giga counts/d	Giga counts/d

Permit Limits are expressed as monthly geometric means

Appendix B. Load Duration Curves and Calculated MS4 WLAs & NPS LA



Lower Kansas River E coli TMDL for Nov-Mar



Calculation of MS4 WLAs and Load Allocations for NPS (Loads in Giga-counts/day)

	Winter	Winter	Incremental	Winter	Winter	Winter
Flow Condition	Lecompton	Load KC	Load	Winter	MS4	WLA LA
			Ld	WLA		
Dry - 90%	54389	64714	10325	10325	0	0
Low - 75%	75556	87588	12032	10325	495.03	1211.97
Normal - 50%	144192	158935	14743	10325	1281.22	3136.78
High - 25%	313905	350933	37028	10325	7743.87	18959.13
Wet - 10%	663282	759871	96589	10325	25016.56	61247.44

	Summer	Summer	Incremental	Summer	Summer	Summer
Flow Condition	Lecompton	Load KC	Load	Summer	MS4	WLA LA
			Summer	WLA		
Ld						
Dry - 90%	7882	9232	1350	1350	0	0
Low - 75%	13073	14759	1686	1350	97.44	238.56
Normal - 50%	26531	29841	3310	1350	568.4	1391.6
High - 25%	66649	76696	10047	1350	2522.13	6174.87
Wet - 10%	153164	170794	17630	1350	4721.2	11558.8

Calculation of Individual MS4 Wasteload Allocations at High Flows

					Wet - 10%	Wet - 10%
MS4 Area	Drainage Area (sq.mi.)	Pct of Ks River	Pct of MS4's		Winter WLA	Summer WLA
Lawrence		28.75	2.35	8.06	2015	380
Bonner Springs		16.09	1.31	4.51	1128	213
KC KS/WY Co		70.88	5.78	19.86	4968	938
Shawnee		42.65	3.48	11.95	2990	564
Olathe		37.57	3.06	10.53	2633	497
Lenexa		31.62	2.58	8.86	2216	418
Merriam		4.33	0.35	1.21	304	57
Mission		0.89	0.07	0.25	62	12
Remainder of Johnson County		124.12	10.12	34.78	8700	1642
Total		356.9	29.11	100.00	25017	4721
	29% of Kansas River Drainage					

